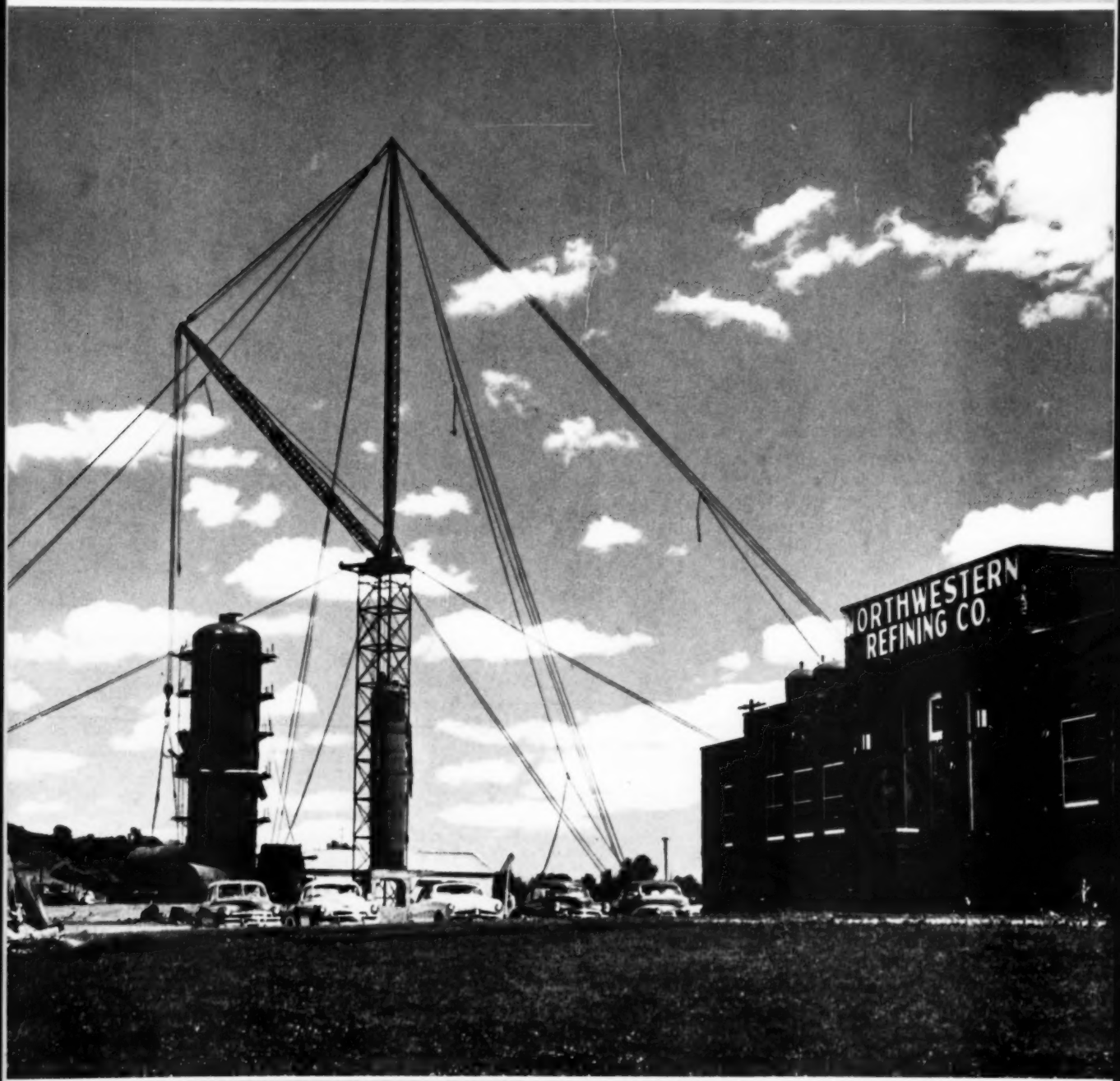
INDUSTRY AND POWER

For Executives and Engineers Responsible For Engineered Plant Services



FEBRUARY 1953

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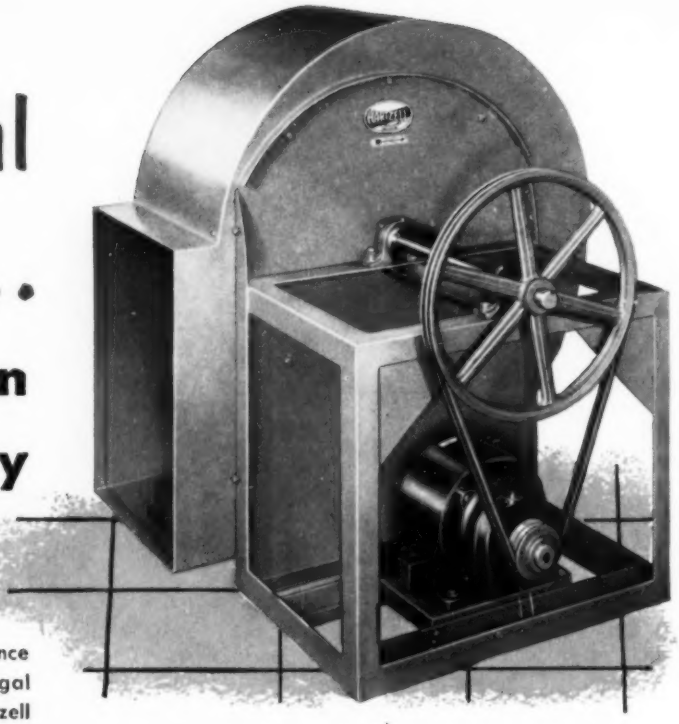
Automatic Combustion Controls for Oil Burners ..... Page 69
Modern Methods for Excluding Air From Transformer Oil .. Page 82

New Centrifugal Blower Line...

Now! Hartzell can meet your utility blower needs



After 27 years of ***industrial*** air-moving experience Hartzell presents their new line of centrifugal blowers. These new blowers, combined with Hartzell propeller-type fans and blowers, round out the line to meet your air-moving requirements

Models to meet practically every industrial need. Belt-drive, direct-drive and special pressure models. Sizes from 4½" to 48". Simple, sturdy, welded-steel construction. Standard and special motors. Speeds to deliver exactly the air needed against almost any pressure.

And they come to you backed by the know-how of your nearby air-minded Hartzell representative.

If you know Hartzell propeller-type fans and vaneaxial blowers you know Hartzell centrifugal blowers ***must*** be good. You know they're built for ***industry***. No divided aim, no compromise with other demands.

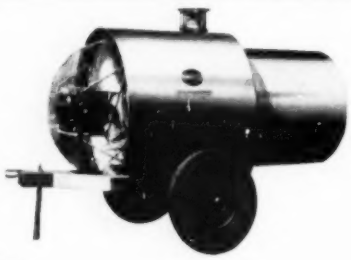
Mail the coupon below, or write for your copy of our new centrifugal blower catalog B-10. It's packed with information.

PROPELLER-TYPE FANS

The famous Hartzell propeller-type fan is made in every conceivable type, from the single-propeller model shown to multiblades, extension-shaft, utility and others.

VANEAXIAL BLOWERS

If you want a powerful blast of high-speed air against pressure, check this blower. Made in belt-drive and direct-drive models, in a wide range of sizes.



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For cold-weather cement laying, heating of large structures under construction and other temporary, shifting needs for large volumes of heat, distributed under high pressure, the Hartzell Hotblast is ideal. Made in 3 sizes—3, 5 and 7½ HP heat-distributing fan—producing hundreds of thousands of BTU. Equipped to burn oil or gas; with electric motor or gasoline engine. Mounted on an all-welded two-wheel trailer. Economical operation, plus powered heat distribution. Write for complete information.

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by consulting Goodyear Distributor

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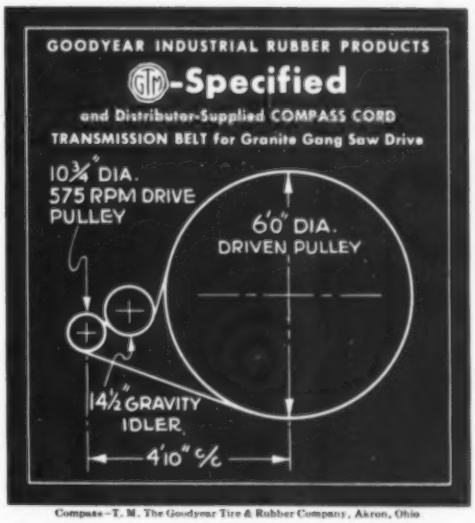
You can get service like this, too—specification of the *right* product and on-call delivery—simply by calling your nearest Goodyear Industrial Rubber Products Distributor. Look for him in the yellow pages of your Telephone Directory—handling Hose, Flat Belts, V-Belts, Packing, Tank Lining, Rubber-Covered Rolls—or write for an introduction to Goodyear, Mechanical Goods Division, Akron 16, Ohio.



Compass—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

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LINK-BELT equipment does either job... better

Get an unbiased recommendation for the right type of railroad car unloader for your needs

Be sure you get the right railroad car unloader for your particular requirements. Only Link-Belt builds both types — the Rotary Dumper for large users ... the low-frequency Car Shaker for smaller operations.

You'll save time and manpower with either. For both are precision-engineered by Link-Belt to do a specific job faster ... more gently ... at lower cost to you.

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Edited specifically for executives and engineers responsible for the selection, installation, operation & maintenance of equipment required for Engineered Plant Services*

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INDUSTRY AND POWER

The Magazine for Engineered Plant Services

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GET RID OF DIRTY OIL . . .
GET LOWER OPERATING COSTS
LONGER EQUIPMENT LIFE

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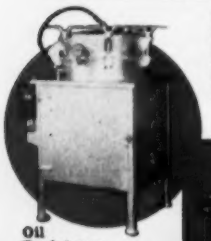
Clean oil at all times reduces down time, increases production and HILCO units pay for themselves in savings.

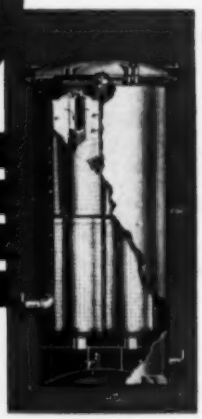
HILCO offers a wide range of oil purification units . . . one to meet your needs. Write us about your equipment . . . and get recommendations at no obligation.

● *THERE'S A* ***HILCO*** *FOR EVERY LUBRICATION AND FUEL OIL FILTERING PROBLEM*



HILCO has 25 years experience in oil purification. Let this experience work for you.

Oil Reclaimer



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FILTERS
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A complete range of sizes and systems for oil purification.

Filter

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Acorns of science

Developments not yet available, but of interest to those responsible for Engineered Plant Services

High Gas Pressures

● A hydraulic compressor which might be a forerunner of equipment for processes using high gas pressure is a product of the Harwood Engineering Company. The Navy has just installed one of two in existence to study behavior of fuels at gun pressure. Unique features of the pump, capable of 100,000 psi are automatic hydraulic control and driving system and use of liquid "pistons". Hydraulic drive avoids mechanical systems composed of gears, cranks and shafts like those in ordinary reciprocating pumps.

Sound Versus Fire

● Possibility of putting out fire by ultrasonic sound waves has been proposed by the National Board of Fire Underwriters. Under certain conditions, flame can be extinguished by sound waves, a fact known by fire protection engineers for many years. Although the phenomenon has so far only reached the status of a laboratory curiosity, new developments with high powered sound above the audible range may lead to investigations of extinguishing fire by its use. This may be important in new processes and materials that are so inherently hazardous that they must be accompanied by appropriate developments in fire protection.

Rarified Reaction

● Information on a new process for making acetylene has been released by Fluor Corporation. Since the gas is a raw material for many synthetic fibers, it may reduce the cost of fabrics made from them. Although invented 25 yr ago, recent developments were necessary to make the process commercially feasible. In a special furnace, direction of gas flow is reversed every 60 sec and reaction is so fast at the 2200 F heat that a vacuum is necessary to prevent the acetylene from reacting with itself to form useless compounds.

Common Rare Earth Elements

● The rare earth elements may become much more familiar. Argonne National Laboratory announces development of a continuous extraction process feasible on an industrial scale that brings bulk production nearer. These elements interest nuclear researchers because some appear as fission products when uranium and thorium are bombarded with neutrons and because of nuclear properties of some. Many have other valuable properties.

Stick-On Resistors

● Applying resistors like a postage stamp seems to be on the way. The National Bureau of Standards has issued a report on a carbon-resin film type resistor in self-adhesive tape form described as suitable for use in printed circuitry. Range covered is 10 ohms to 10 megohms. Asbestos paper tape and silicone resin binder result in a resistor capable of operating at 200 C. Resistor size is fixed and resistance is varied by changing resin to carbon ratio or by changing carbons.

New Thermal Barrier

● As an example of research results carried on by the company years ago, General Electric Company has announced a new thermal insulation under development and ten times as efficient as any now in use. Although not ready for marketing, it is employed in a refrigerator-freezer prototype having walls only one-half inch thick. Potential applications in fields where heat and limited insulation space are factors are suggested.

It's not what you Pay for Valves ...it's what they Cost you

on Steam Heated Machinery

for example

(A Case History)

Crane No. 960 Brass Pressure Regulator, for steam or air, up to 250 psi. See your Crane Catalog.

What you pay for valves is not the final criterion of value. Not when maintenance can quickly equal or exceed purchase price. A thrifty buyer knows his maintenance; knows also there's bigger value in better quality.

Take the case at Dryden Rubber Division of Sheller Mfg. Corp., Chicago. More than 25 years ago, this plant started using Crane Pressure Regulators on steam lines to molding presses. 225 are in service today; many still are the original installations, still working faithfully. The records for all Crane regulators, regardless of age, show no maintenance cost other than prescribed periodic routine servicing.

Today, more than ever, you need greater assurance of quality in piping materials. You get it in Crane Valves—the recognized standard of quality with thrifty buyers everywhere. Your big Crane Catalog offers complete selections for all needs. Your Crane Representative is always ready to serve you.

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VALVES · FITTINGS · PIPE · PLUMBING · HEATING

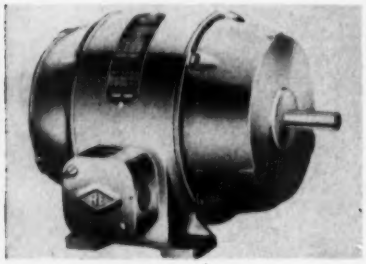
New equipment and developments

Highlights of new products by leading manufacturers

Each new product item has a key number for your convenience in asking for additional, detailed information. Insert key number on return post card on page 115

1—Multi-speed motor provides versatility

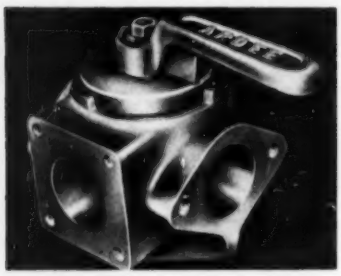
Considerable power versatility is provided for in the design of a multi-speed motor, according to the manu-



facturer, Reuland Electric Co. All units are available in 2, 3 or 4 speeds with constant torque, variable torque or constant horsepower. Sizes range from ½ to 150 hp. Standard, totally-enclosed, splash proof and explosion proof designs are available. Specifications are listed in a bulletin.

2—Recirculating valve features unusual design

Ardee Manufacturing Co. has developed a recirculating valve that may be used for any stream dividing application of gases, air, salt water, oil or mild chemicals to 125 psi. The design,



which combines plug valve principles with O-ring sealing, is said to reduce handle loads and internal wear and to provide protection against leakage. Units are now produced in 2 in. size with flange connections.

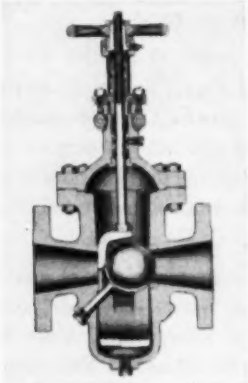
3—Insulating compound applies like tape

Putty-like electrical insulating compound, developed by Minnesota Mining and Manufacturing Co., is produced in rolls for application like tape. The material, known as Scotchfil, fuses

into a void-free mass after application. Besides insulating, it is used to pad sharp corners, build up cable splices, and fill voids around irregular shaped connectors prior to taping. Dielectric strength is 350 v per mil, and insulating resistance is 100,000 megohms. A 4-page brochure presents technical data.

4—Valve employs ball for disc

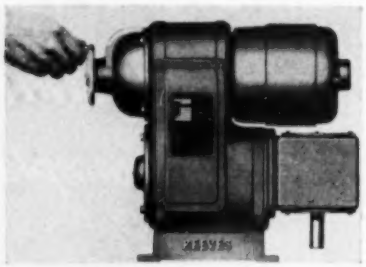
Instead of the conventional shape, the disc of the Crane-Paul valve is a ball. Crane Co. explains that this ball, which is unattached, rides in a cage attached to the stem by tee-head slotted construction. Advantages include accurate flow control with minimum wire-drawing; straight-through flow with low pressure drop; tight shut-off; and freedom from chattering. A wide range



of sizes are offered, beginning with 1 in. Cast steel units in 150, 300 and 600 lb and alloy units in 150 and 300 lb classes are available.

5—Variable speed unit has right angle drive

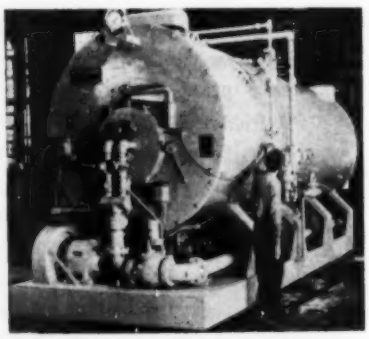
Savings of space are provided by a fractional horsepower Vari-Speed Motodrive with right angle reducer, designed by Reeves Pulley Co. Horizontal models are available with the output shaft driving up, down or at right angles, while in verticle types the shaft drives either down or at right angles. Speed ratios from 2:1 to 10:1 are of-



fered. Design features and methods of control are discussed in an available bulletin.

6—Steam generator provides accessibility

Ames Iron Works announces the addition of a 600 hp self-contained unit to their line of Amesteam generators. It is designed for steam pressures from



15 to 200 psi and for firing with oil, gas or oil-gas combination. The design is said to provide full accessibility. Both burner head and flue cover are davit-hinged for quick inspection. Units are complete with burners and controls.

7—Belt lube comes in pressure can

For convenience in applying, Alexander Brothers Belting Co. announces the use of pressure cans in conjunction with their spray type liquid belt lube. The lubricant is released in a fine mist by pressing the nozzle. It is said to restore flexibility, prolong life and stop slippage of leather, rubber and fabric transmission belts.

(Continued on page 12)

Cut Your V-Belt Costs Right Now!

—this test tells how!

If you want longer V-Belt wear and lower V-Belt costs just make this simple test. Bend any V-Belt that has *straight sides* and—as it bends—*feel* the sides bulge out! (See Fig. 1-A, below)

This out-bulge forces the belt to press unevenly against the V-pulley and of course wear on the belt is concentrated where it bulges most. Naturally this shortens the life of a *straight-sided* V-Belt.

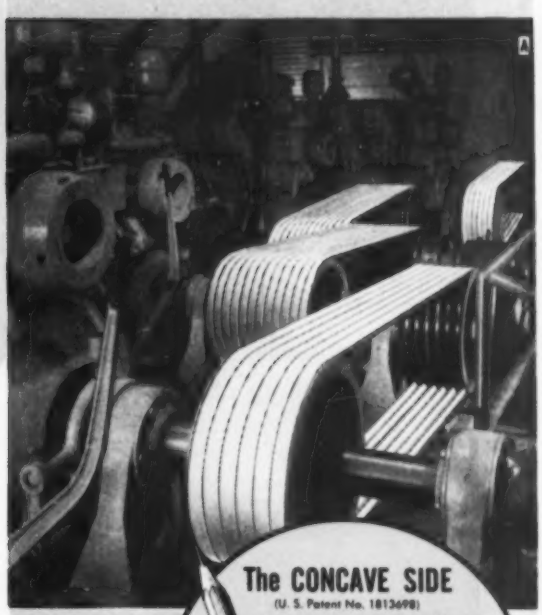
Now, make this same test with the belt that is built with *concave sides*—the Gates Vulco Rope!

See the difference? There is no *out-bulge!* The precisely engineered concave sides *fill out* and become *perfectly straight.* They now *exactly fit* the sheave groove and therefore *press evenly* against the V-pulley. This distributes all wear *uniformly* across the *full width* of the Gates Vulco Rope. And this means longer belt life and *lower belt costs* for you.

Only V-Belts made by Gates are built with concave sides. Whenever you buy V-Belts, be sure that you get the V-Belt with Concave Sides—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

Multiple engines and generators were installed to supply power during the development of Chicago, Wilmington and Franklin Coal Company's Waltonville, Illinois, Coal Mine. The engines had to be connected to the generators with a drive that would absorb vibration and also be completely reliable—so these Gates V-Belts were installed. Mr. Rodenbush, Superintendent, says, "The Gates Vulco Rope Drives have been entirely satisfactory in every way."



What Happens When a V-Belt Bends

Straight-Sided V-Belt

How a Straight-Sided V-Belt Bulges in the Sheave-Groove. Sides Press Unevenly Against the V-Pulley, Causing Extra Wear at Point Shown by the Arrows.

Gates Vulco Rope With Concave Sides

The Concave Sides Fill Out to Precise Fit in Sheave-Groove. No Side-bulge! Sides Press Evenly Against the V-Pulley —Uniform Wear and Longer Life!

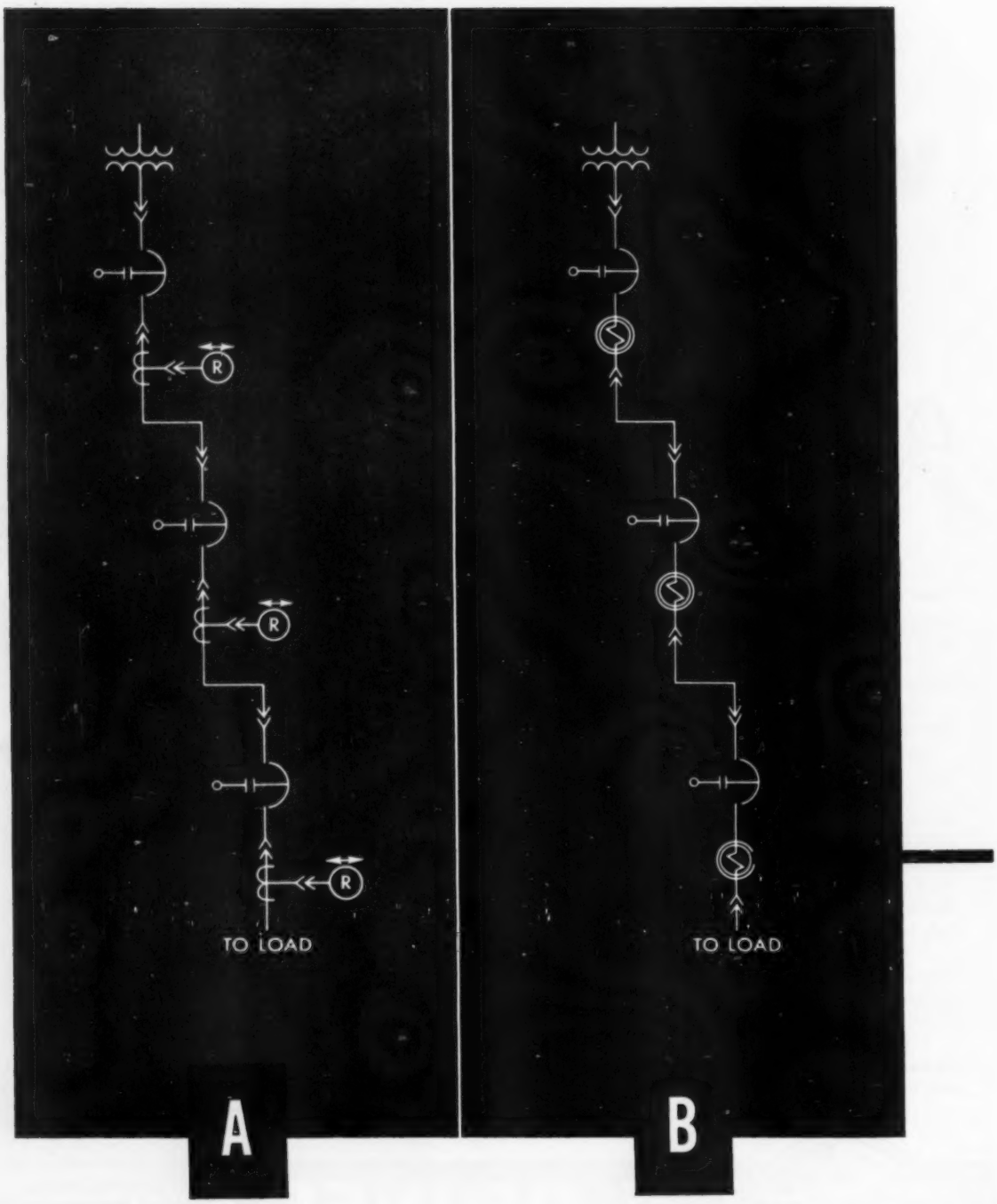
CS-531

Gates® VULCO ROPE DRIVES

THE GATES RUBBER COMPANY • DENVER, U.S.A.

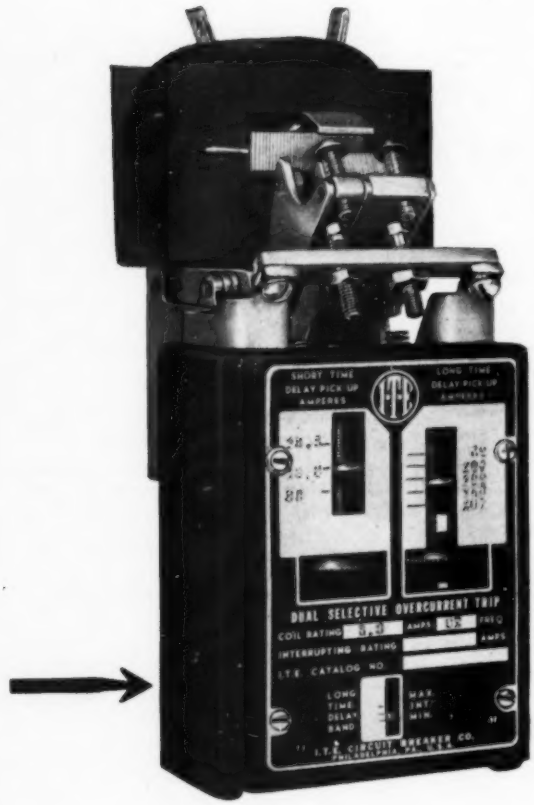
V-Belts—Hose Molded Rubber Goods for industry World's Largest Maker of V-Belts

Both systems provide



selective trip circuit breaker protection

but this *direct-acting* device on I-T-E circuit breakers cuts initial cost and saves space



These two systems were designed to perform identical functions. System **(A)** is costlier, takes more space, and requires a greater degree of skill to maintain.

System **(B)** represents the latest thinking in low-voltage system reliability and introduces the use of I-T-E circuit breakers with direct-acting dual-selective overcurrent trip devices. Savings in initial investment, in space, and in over-all maintenance are achieved.

Recent installations in central stations, processing industries, and manufacturing plants have proved that I-T-E circuit breakers with direct-acting selective overcurrent trips should be carefully considered for every new installation.

I-T-E

LOW-VOLTAGE SWITCHGEAR

I-T-E CIRCUIT BREAKER COMPANY • 19th & Hamilton Sts. • Philadelphia 30, Pa.

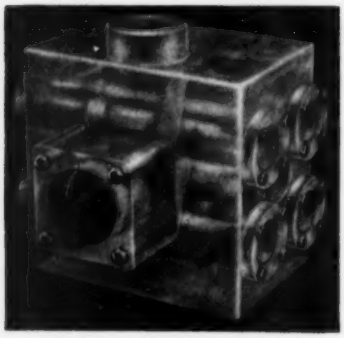
EPD—CANADIAN MFG. & SALES: EASTERN POWER DEVICES, LTD., TORONTO

New equipment and developments

(Continued from page 8)

8—Valve controls ion-exchange cycling

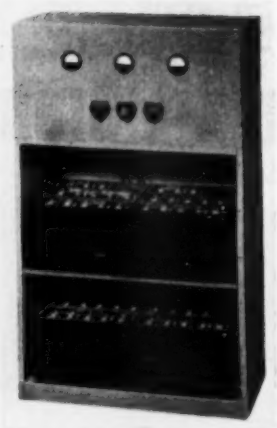
Contaminating leakage is said to be eliminated in the Cycloflow valve, designed by American Water Softener Co. to control cycles of flow in ion-exchange equipment. This is accomplished by providing an isolated section, connected to waste, between the outlet and sources of contamination.



The unit, for manual or automatic operation, can be completely disassembled in 20 minutes without removing piping connections. Four double-acting pistons give positive valve action.

9—Power system uses nickel cadmium batteries

Emergency power is supplied instantly and automatically by a system developed by Electric Cord Co. Automatic charging is listed as an important feature. Nickel cadmium batteries, used in the unit, are said to offer such advantages as 20 to 30 years useful life with addition of water once a year. They cannot be overcharged, do not deteriorate or discharge when idle, and are highly resistant to shock, vibration, low temperatures and occasional excessive discharge and short circuits. The units, known as Light Warden, are available in 6, 12, 24, 32 and 110 v with ampere capacity to meet requirements.



TO REQUEST ADDITIONAL FREE DATA

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11—Speed reducer has overload protection

For overload protection, Philadelphia Gear Works has developed an automatic shut-off device for the type Hat worm gear speed reducer. The device, known as double torque control, eliminates the need for a sheer pin. It restarts automatically when excessive load is removed. The reducer, recommended for drives on such equipment as conveyers, stokers, rolls and tumblers, is offered in a wide range of horsepowers with speed ratios from 3⅝:1 to 6300:1.

12—Nylon anode bags resist chemical action

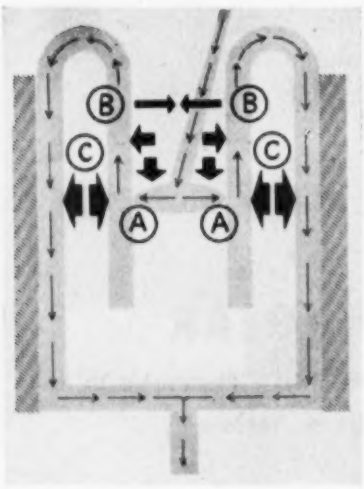
Specially treated nylon fabric for anode bags and diaphragms, used to screen anode sludge from plating solutions, increases the life and reduces replacement costs, according to the manufacturer, Hanson-Van Winkle-Munning Co. Known as NW Nylon, it is said to offer increased resistance to chemical action and abrasion, particularly to hot caustic solutions, and does not become salt incrusted.

13—Relay has sealed silicone time element

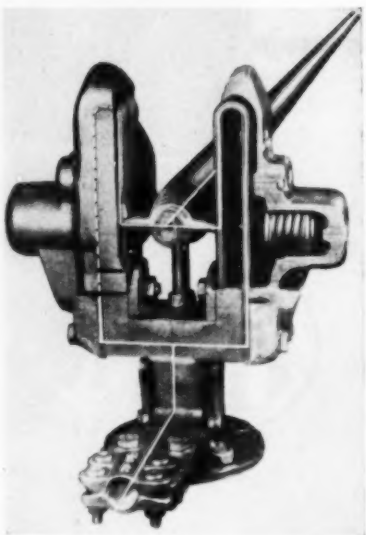
High speed operation under dangerous conditions is combined with time delay for starting inrush in an over-

(Continued on page 16)

10—Switch design utilizes magnetic field



Magnetic fields effect higher contact pressure in an air break switch known as Amplitact, according to the manufacturer, Southern States Equipment Corp. Increased current flow is said to cause a proportionate increase in contact pressure, thus providing greater current carrying capabilities. The principle of operation is shown in the diagram. Referring to (A), current flowing through the blade changes direction 90 degrees at the junction with a resilient inner segment of a loop, thus producing forces which tend to hold the blade in closed position. At (B), current flows in parallel paths and in the same direction in both segments, which causes the conductors to attract and thus increase contact pressure. At (C), path of current in the resilient segments and in fixed outer segments is parallel, but flowing in opposite directions. Because of close proximity, a force from opposing magnetic fields amplifies the contact pressure in proportion to the square of the current.



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For LOW-COST UPJOHN burns COAL

UPJOHN'S new pharmaceutical plant which includes units for production of penicillin and cortisone, as well as some 700 other pharmaceutical products, relies on coal for dependable steam.

This ultramodern boiler house supplies steam, cleanly and efficiently, at only 40¢ to 42¢ per 1,000 lbs. It delivers 115,000 lbs. per hour at peak load for the Portage Road Plant near Kalamazoo, Michigan.

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For both efficiency of operation and economy, you just can't beat coal burned the modern way!

If you operate a steam plant, you can't afford to ignore these facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—*for hundreds of years to come.*

COAL production in the U.S.A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

FOR HIGH EFFICIENCY
FOR LOW COST

DEPENDABLE steam, the modern way!

CLEAN, CONVENIENT!

This view of Upjohn's firing aisle shows how clean and convenient coal can be when handled and burned the modern way. The stoker hoppers are fed from an overhead bunker. A 2-ton capacity weigh larry serves all boilers.

The ash handling is fully automatic. Traveling grates continually discharge ashes into hoppers below the floor of the firing aisle.

The 3 boilers shown, plus a fourth recently installed (not illustrated), supply all Upjohn's steam needs.

• Whether you're building a new plant or modernizing an older one, you can count on coal for dependability and low-cost operation.

Here's why: Up-to-date coal-burning equipment can give you 10% to 40% more steam per dollar. Automatic coal- and ash-handling systems can cut your labor cost to a minimum. Let a consulting engineer show you how a modern coal installation, tailored for your specific needs, can save you real money.

Here's something else, too—of all fuels, coal alone has virtually inexhaustible resources. This, plus the fact that America's coal industry is the most efficient in the world, assures you of a dependable supply of coal at relatively stable prices now and for years to come.

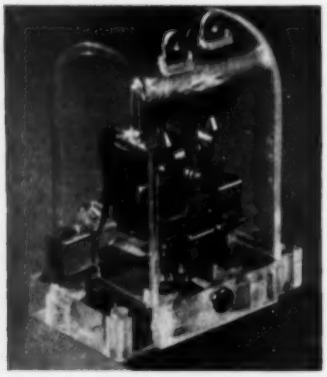
BITUMINOUS COAL INSTITUTE
A DEPARTMENT OF NATIONAL COAL ASSOCIATION
WASHINGTON, D. C.

YOU CAN COUNT ON COAL!

New equipment and developments

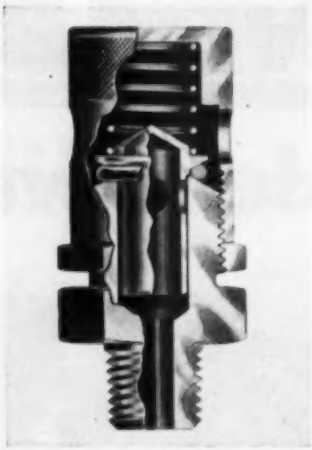
(Continued from page 12)

load relay developed by Heinemann Electric Co. Known as type C Silic-O-Netic, it can be furnished with delay curves to match equipment characteristics. Its high speed response point also provides protection for hermetically sealed motors, electronic circuits and control systems. Units are insulated for 440 v service with coil ratings from 1 to 100 amp. A bulletin describes principles of operation.



14—Relief valve controls low pressure gases

For controlling gases safe to release to atmosphere, James-Pond-Clark has developed an adjustable, precision low-pressure relief type valve, designated series 5400. It employs a replaceable O-ring which is self aligning between two conical seats of a poppet type valve. Relief pressures are from 2 to 45 psi. Units can be set at the factory or by the user. Standard units have ⅛ or ¼ in. male pipe threads and operate at temperatures from 40 to 280 F.



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16—Valve provides fast emergency control

Developed by McRae Corp. for use with fire and emergency control systems, a piston operated quick opening valve affords flexibility and speed of action. Any number of units can be operated from one set of controls. They also can be closed by remote control and can be operated manually or in combination with fire fused seals, pneumatic controls, or open or closed circuit solenoid. Uses range from opening water into emergency systems to dumping process vessels to outside storage during a fire.

17—Platform scale employs outboard bearings

Longer life and less maintenance result from the use of main lever bearings located outside the weighing platform area of the Detecto dormant platform scale, according to Detecto Scale Inc. Other improvements include all-steel construction and an improved dial mechanism. The dial can be swiveled through 360 degrees to permit reading from any location.

18—Synthetic lubricants for gas compressors

Sulfur-free synthetic lubricants for compressors have been developed by Carbide and Carbon Chemicals Co. Known as Ucon brand, they are produced in both water-soluble and water-insoluble series. They do not poison sulfur-sensitive catalysts, and are resistant to formation of varnish, sludge, or carbon. Recommended uses include compressors handling such gases as nitrogen, hydrocarbons and air. Many types have low solubility in aliphatic hydrocarbons. They are supplied in a wide range of viscosities, and are reported to have high viscosity indexes, low pour points, and excellent lubricity.

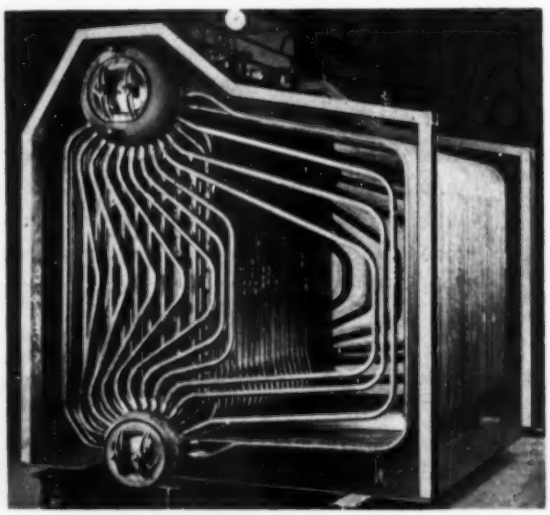
(Continued on page 20)

15—Package boiler has sectional casing

Package type water tube boilers designed to meet present day requirements for steam and high temperature hot water are now being manufactured by Springfield Boiler Co. Units are offered in sizes from 7500 to 30,000 lb of steam per hr, or equivalent water ratings, and in design pressures of 200, 300, 600, and 900 psi. They are 2-drum, bent tube design featuring a water cooled furnace in which tangent water tubes completely shield the full length combustion chamber. Large water capacity gives the boilers exceptional ability in handling heavy peak and fluctuating loads. Provision for superheat up to 200 F is available as auxiliary equipment.

Firing is by oil, gas or combination burners. Units are available without burners or with complete burner and control assembly. The boilers are enclosed in a gas tight insulated steel jacket of sectional design and are suitable for outdoor as well as indoor installation. Although units are normally shipped assembled, the sectional casing and standardized sectional parts permit field assembly, when required, with minimum labor in the field.

Where the boilers are used as first stage forced circulation units for high pressure, high temperature water systems, the design includes provision in the boiler drums to permit natural circulation through the furnace heat absorbing tubes in case the high pressure circulatory pumps or lines accidentally fail to return any or all of the system water to the boiler.



WHY BE

STYMIED

BY CARRYOVER and BLOWDOWN?

Impure steam and excessive blowdown are two problems that need not be tolerated by any power plant engineer, thanks to effective anti-foam agents.

Within recent years, the Betz organization has developed several anti-foam agents which have produced remarkable results both from a standpoint of better boiler operation as well as direct savings.

For instance, a southern chemical plant installed a new high pressure boiler and turbine to operate in conjunction with the existing lower pressure boilers and turbines. To minimize silica vaporization, the condensate of all boilers was returned to the high pressure system. As a result, difficulties were encountered in the operation of the low pressure system—high boiler water solids developed causing severe carryover, and the low pressure turbines eroded seriously.

After analysis, Betz Engineers recommended the application of anti-foam agents which *immediately* remedied this carryover condition. The solids content of the steam was reduced to 2 ppm at high boiler ratings without any increase in blowdown.

The positive control of carryover and boiler blowdown is just *one* of the *many* services offered by the Betz Organization. Let a Betz Engineer explain to you how our *complete* engineering guidance can help you solve all your water problems. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

For the complete story on carryover and blowdown control through the use of anti-foam agents, write for Technical Paper No. 115.

BETZ

CONSULTANTS ON ALL WATER PROBLEMS

here's why

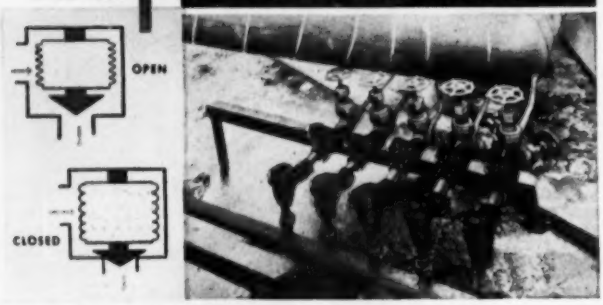
they selected 4 different types of steam traps for 4 different applications

CONDITIONS under which steam traps must operate vary widely, but there is for every service one type that gives maximum efficiency.

Sarco makes the 4 distinctly different TYPES of steam traps shown below. Therefore, Sarco can give you *impartial* advice on the best choice for your particular installation.

For each of the 4 jobs listed below, the users selected four different TYPES of Sarco traps.

CASE NO. 1 — Draining outside tracer lines in an oil refinery in New Jersey



Type of traps installed: Sarco No. 9 thermostatic traps.

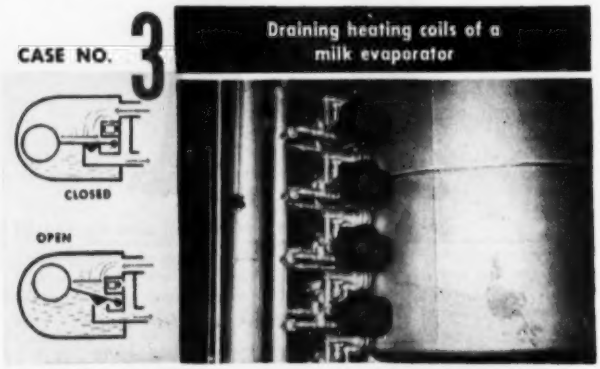
Why selected: Being thermostatic, they are steam misers. Can't freeze, being wide open when cold. Easy to maintain since only the bellows moves. Small, light and easy to install. Self-adjusting for different pressures.

CASE NO. 2 — Draining platens of compression plastic presses

Type of traps installed: 100 Sarco Inverted Bucket traps in service for 17 years.

Why selected: Press platens have small horizontal steam spaces; the intermittent blast discharge of these Sarco traps scours the heating surface. Built-in strainer cuts maintenance costs.

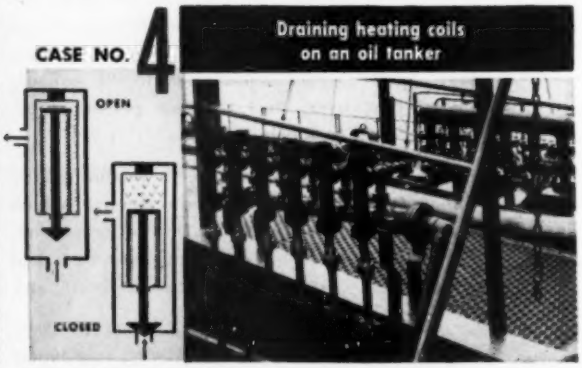
CASE NO. 3 — Draining heating coils of a milk evaporator



Type of trap installed: Sarco Float-Thermostatic Trap.

Why selected: Heating surfaces of the coils must be kept full of live steam — this Sarco trap discharges condensate as it collects. Can't airbind because the integral thermostatic vent gets rid of air, regardless of operating steam pressure and temperature. As shown in sketch 3 above, this vent does *not* depend upon the discharge of condensate.

CASE NO. 4 — Draining heating coils on an oil tanker



Type of traps installed: Sarco LIQUID EXPANSION traps No. 871.

Why selected: Traps on tankers are exposed to freezing weather and vibration. Sarco's No. 871 traps can't freeze; resist vibration, water-hammer, pressure pulsations and superheat. These traps discharge condensate at adjustable temperatures below 212°F., permitting use of some of the condensate's sensible heat.

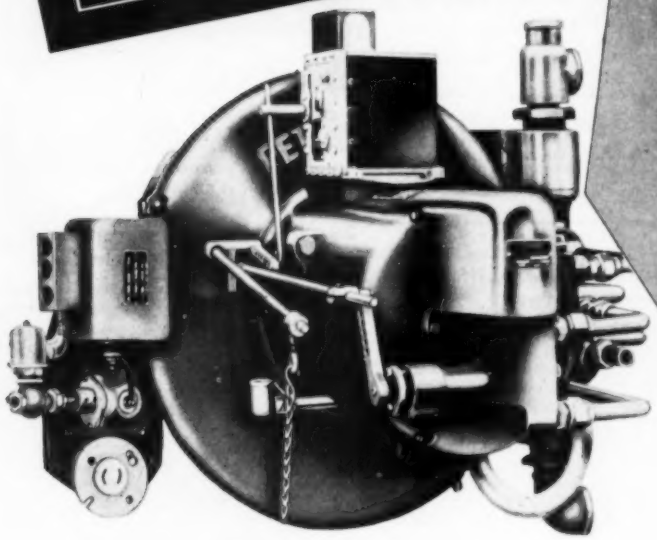
● Write today for Bulletin No. 145-A: *Selecting the Right TYPE Steam Trap.* Sarco Company, Inc., Empire State Bldg., New York 1, N. Y. Represented in principal cities. Sarco Canada Ltd., Toronto 8, Ontario.

408

SARCO saves steam

improves product quality and output

Are steam costs YOUR responsibility?



MODERNIZE WITH A Petro INDUSTRIAL OIL BURNER

...and cut steam costs!

HERE'S WHAT PETRO WILL DO FOR YOU:

LOW FIRST COST

Petro industrial oil burners are designed and built to *modernize* the firing of your present boilers. This means that you save substantially on initial installation costs—yet enjoy the efficiency, the dependability, and the complete automatic operation that has been traditional with Petro burners for over 50 years.

LOWER FUEL COSTS

A Petro oil burner's economy is unchallenged. You save two ways. First, you save on fuel cost, because heavy oils cost less per gallon and have higher heat value. And second, a Petro burner is designed to burn these low-cost, heat-rich heavy oils with complete dependability. Whether the oil is thick or thin a Petro feeds it steadily under precise automatic control. You get more efficient firing.

UNUSUAL FLEXIBILITY

Here is another Petro value. Under automatic modulating flame control it is extremely flexible in following fluctuating steam demands. If yours is a problem of "high and low" steam requirements—than a Petro burner is your answer. It follows the load without hesitation, and throttles down to a steady low burning rate if desired.

LOWER OPERATING COSTS

Petro Industrial Oil Burners are completely automatic. They require a minimum of supervision. Boiler rooms stay clean. The simple, sturdy design of the Petro burner and its easy accessibility reduce upkeep to a minimum—save you money year after year.

Leading heating contractors everywhere recommend and install Petro oil burners. See your contractor, or mail coupon below.

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Name_____

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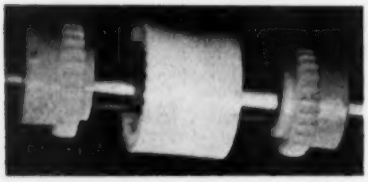
New equipment and developments

(Continued from page 18)

19—Nylon coupling does not require lubrication

Many advantages are claimed for an inexpensive gear type coupling developed by John Waldron Corp. Made of nylon, it is said to be durable, non-magnetic, non-corrosive and does not re-



quire lubrication. Units are available with hub bores from ⅛ to ¼ in. Specifications are listed in a data sheet.

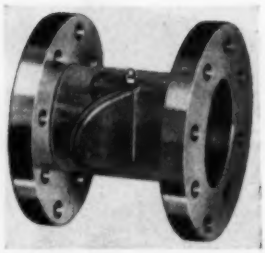
20—Plastic cable clamp offers many advantages

Saran, a non-inflammable and pliable plastic, has been used in a cable clamp developed by Holub Industries, Inc. Important characteristics listed for the plastic include excellent electrical

and thermal properties, inertness to fungicidal attack, resistance to atmospheric conditions and to mild acids, chemicals and oil. Seventeen sizes from ⅛ to 1¼ in. are available for use with wires, cable, pipe or tubing.

21—Check valve utilizes simple construction

Simplicity of construction is featured in a check valve designed by Techno Co. for use on air or gas lines. A seatless, semi-flexible feathering type valve closes quickly and tightly against reverse flow. Pressure drop is said to be



½ in. water at 2000 cfm and 25 psi. Units for pressures to 50 psi and temperatures to 200 F are standard. Flanged or screwed ends from 4 to 16 in. are available.

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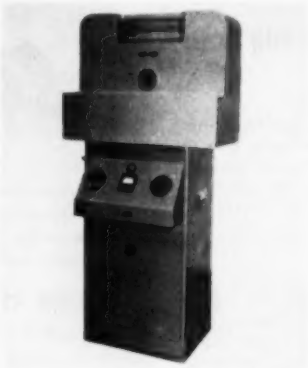
Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

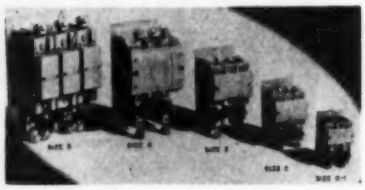
23—Degreaser cleans with ultrasonic waves

Ultrasonic waves are used to clean metal parts in the Circosonic degreaser manufactured by Topper Equipment Co. Heart of the unit is an ultrasonic generator developed and manufactured by General Electric Co. The equipment, which is available for continuous production or batch work, is said to efficiently remove such contaminants as oil, grease, chips and lapping compound at a rate hitherto unobtainable.



24—Motor control features smaller size

Vertical overloads below the contactor are featured in the RA-V magnetic motor starter manufactured by The Industrial Control Div. of The Arrow-Hart & Hegeman Electric Co. Much smaller and lighter in weight than conventional units, this right angle control is designed expressly for use with



the Crouse-Hinds M52, type EPC explosion proof condulet, commonly used in the petroleum, chemical and petro-chemical industries.

25—Unit heaters incorporate electric heating elements

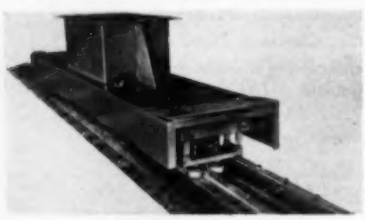
Three types of unit heaters, incorporating Hynes electric heating elements, have been developed by L. J. Wing Mfg. Co. for applications where steam,

hot water and gas are not practical. Ratings are from 13,600 to 204,000 Btu per hr with discharges from 235 to 3600 cfm. In addition to the suspended downward discharge unit with revolving outlets, shown in the illustration, similar units with stationary outlets and models with horizontal discharge are available.

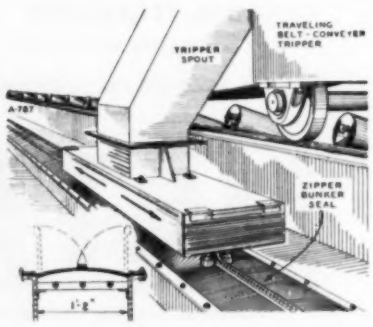
(Continued on page 24)

22—Zipper on bunker seal prevents dust

To prevent dust caused when traveling belt conveyer trippers discharge into extended storage bunkers, Ste-



phens-Adamson Mfg. Co. has developed the S-A Zipper Bunker Seal. Although designed primarily for power plant coal systems, it is equally effective in other industries using traveling trippers. Flat belts fastened to the edges of the bunker have Zipper teeth which mesh tightly to form a dust-proof connection. An opening and closing mechanism hangs from the tripper spout and opens the belt only under the discharge point. Grate bars under the seal belts protect against injury due to stepping on or through them. Design is discussed in a 4-page bulletin.



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It's bad air that does it. But you can step up production by putting a Coppus Blower on the job to keep the air moving — and keep the men cool.

The kind of air a man works in has a lot to do with how much work he can turn out.

In confined places like shipholds or tanks or drums or boilers . . . or wherever the air is stagnant or hot or full of fumes . . . a Coppus Blower is a *must* for getting first-class work out of the men, all the time.

A Coppus Blower or Exhauster helps avoid sickness and lassitude due to bad air . . . and improves morale, too.

Portable and adaptable for special purposes, Coppus Blowers and Exhausters will have dozens of uses around your plant. The "Blue Ribbon" (a blue painted band) is your assurance of quality performance at lowest cost.

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THE BLOWERS THAT PUT MORE MINUTES IN EVERY MAN HOUR

CABLE MANHOLE AND TANK VENTILATORS — BOILER MANHOLE BLOWERS AND EXHAUSTERS — HEAT KILLERS — SHIPHOLD VENTILATORS . . . DESIGNED FOR YOUR INDUSTRY — ENGINEERED FOR YOU

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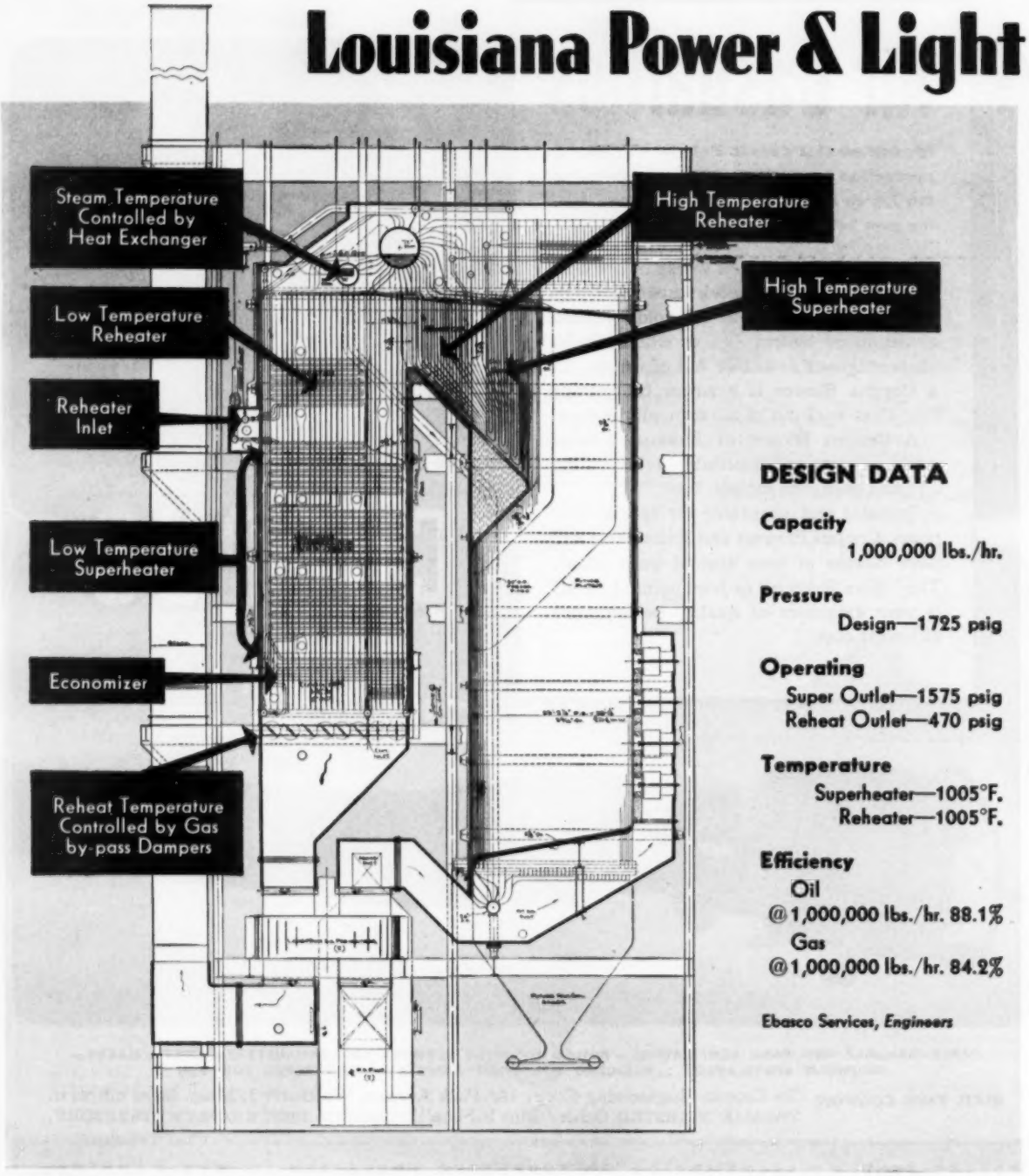
(Write here any special ventilating problem you may have.)

Louisiana Power & Light



DESIGN DATA

Capacity
1,000,000 lbs./hr.

Pressure
Design—1725 psig

Operating
Super Outlet—1575 psig
Reheat Outlet—470 psig

Temperature
Superheater—1005°F.
Reheater—1005°F.

Efficiency
Oil
@1,000,000 lbs./hr. 88.1%
Gas
@1,000,000 lbs./hr. 84.2%

Ebasco Services, *Engineers*

TRADE MARK Rx REGISTERED

RILEY

STOKER CORPORATION, WORCESTER, MASS.

Boston · New York · Philadelphia · Washington · Buffalo · Pittsburgh · Cleveland · Detroit · Chicago
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BOILERS • PULVERIZERS • BURNERS • STOKERS • SUPERHEATERS • ECONOMIZERS

first to use Reheat with Natural Gas

Louisiana Power & Light Company's 1,000,000 lbs./hr. pressure furnace Riley Reheat Unit will be the first reheat unit fired by natural gas and oil to be installed by the Public Utility industry.

Several features of Riley Unit for Louisiana Power & Light Company

Separate Independent Control of Superheater and Reheater Temperatures.

Maintenance of desired superheater and reheater steam temperatures is obtained by different and independent controls so that an adjustment to the temperature of one does not effect the final temperature of the other. Reheater temperature is controlled by varying the quantity of gas passing over the low temperature reheater sections by means of dampers beyond the economizer. Superheater temperature is controlled by means of a heat exchanger which regulates the temperature of steam entering the high temperature superheater section so as to give the desired superheater outlet temperature over the desired load range.

All Tubes Welded to Stub Tubes. *No Rolled Joints.*

All tube connections to drums and headers of boiler, water walls, superheater and economizer are welded, not rolled and merely seal welded. Stub tubes are shop welded into drums and headers prior to shipment for field weld of tubes thereto.

Furnace Pressurized. *No Induced Draft Fans.*

The unit is a pressurized furnace unit operating with forced draft fans only. The furnace will operate under a pressure of approximately 7.25″ of water. The use of a pressurized furnace reduces over-all fan power requirements and increases efficiency because of lower excess air.

A Few Recent Riley Units for Public Utility Plants

DEPARTMENT OF WATER AND POWER
CITY OF LOS ANGELES, CALIFORNIA
1,200,000 lbs./hr. 2075 psig, 1000°F. and 1000°F. reheat.

LOUISIANA POWER & LIGHT CO.
1,000,000 lbs./hr. 1725 psig, 1005°F. and 1005°F. reheat.
Ebasco Services, *Engineers*

HOUSTON LIGHTING & POWER CO.
1,200,000 lbs./hr. 1700 psig, 1005°F.
Ebasco Services, *Engineers*

SOUTHWESTERN GAS & ELECTRIC CO.
630,000 lbs./hr. 1050 psig, 1005°F.
Sargent & Lundy, *Engineers*

MONONGAHELA POWER CO.
700,000 lbs./hr. 1050 psig, 905°F.
Sanderson & Porter, *Engineers*

UTAH POWER & LIGHT CO.
575,000 lbs./hr. 1700 psig, 1000°F. and 1000°F. reheat.
Bechtel Corp., *Engineers*

CENTRAL ILLINOIS LIGHT CO.
600,000 lbs./hr. 950 psig, 900°F.
Commonwealth Services, *Engineers*

NORTHERN STATES POWER CO.
385,000 lbs./hr. 1500 psig, 950°F.
Pioneer Service & Engineering, *Engineer*

SOUTH CAROLINA PUBLIC SERVICE AUTHORITY
460,000 lbs./hr. 1025 psig, 900°F.
Ford, Bacon & Davis, *Engineers*

THE POTOMAC EDISON CO.
700,000 lbs./hr. 1050 psig, 905°F.
Sanderson & Porter, *Engineers*

IOWA ELECTRIC LIGHT & POWER CO.
300,000 lbs./hr. 975 psig, 910°F.

GULF POWER CO.
325,000 lbs./hr. 1000 psig, 900°F.
Southern Services, *Engineers*

SOUTH CAROLINA GAS & ELECTRIC CO.
400,000 lbs./hr. 1475 psig, 955°F.
Gilbert Associates, *Engineers*

UTAH POWER & LIGHT CO.
620,000 lbs./hr. 1500 psig, 955°F.
Bechtel Corp., *Engineers*

IOWA-ILLINOIS GAS & ELECTRIC CO.
250,000 lbs./hr. 975 psig, 905°F.

PUBLIC SERVICE CO. OF INDIANA
400,000 lbs./hr. 1000 psig, 910°F.
Sargent & Lundy, *Engineers*

A survey of your Power Plant by a consulting engineer will possibly show ways of making surprisingly large savings in your power costs

COMPLETE STEAM GENERATING UNITS

. . . it will pay you to visit modern Riley Installations before purchasing Boiler or Fuel Burning Equipment

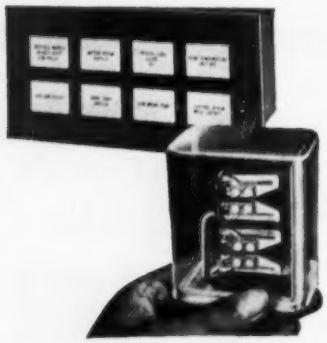
WATER-COOLED FURNACES • STEEL-CLAD INSULATED SETTINGS • AIR HEATERS

New equipment and developments

(Continued from page 20)

26—Alarm system utilizes plug-in units

Interchangeability of circuits and functions are provided in the Panalarm 50 plug-in annunciator system designed by Panalarm Products, Inc. A sin-



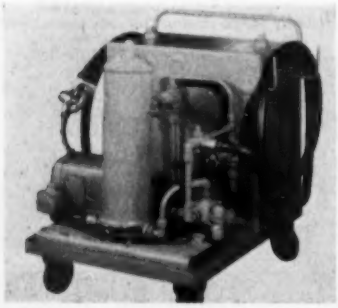
gle unit can be used to warn of any off-normal condition throughout a plant. Units provide 3 to 54 individual signals. Audible signal by horn plus visual signals by light or lighted panels are provided. Construction is described in an available bulletin.

27—Non-slip handwheel standard for valves

Four finger-spaced lugs, all continuations of the spoke structure projecting from the stem hub through an octagonal frame, are featured in a non-slip handwheel designed by The Lunkenheimer Co. The company will standardize on the new handwheel for its complete line of bronze and iron valves. Available literature lists ease of turning and increased safety as the principle advantages.

28—Portable unit filters hydraulic oil

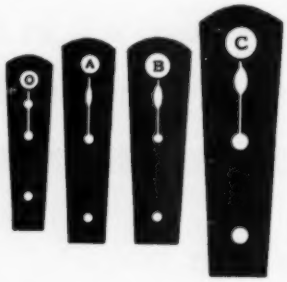
Portable hydraulic filter units for pumping hydraulic oil from a machine through the filter and back into the machine or into tanks are being assembled by J. N. Fauver Co., Inc. Principle equipment consists of either a 20 or 55 gal portable tank, Cuno filter,



Yale and Towne model 20 pump, Crane valves and 3-way cock, and a ½ hp motor.

29—V-link belting features improvements

Brammer Corp. announces several improvements in their line of V-link belting. A symbol embossed on each



rivet head simplifies size identification. Also a natural rubber compound is used to increase flexibility of each link. Easier assembly and greater surface contact is said to be the result.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

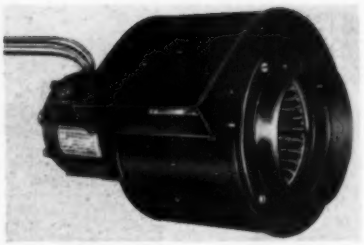
30—Packless globe valve for hydraulic service

For hydraulic, pneumatic and vacuum service, George W. Dahl Co., Inc. has developed a packless globe valve which is described as tamper proof. Known as model DEMI-G, it can be applied to oil, water, gas and corrosive

systems. Units are available threaded for a maximum pipe size of ¼ in., or with ¼ in. integral tubing connections.

31—Blower cools electronic equipment

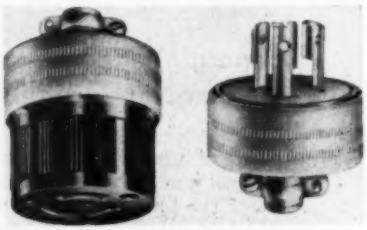
Applications such as cooling transmitting tubes, cabinets, chassis, amplifier assemblies and electronic controls are listed for a 60 c, single phase blower developed by Induction Motors



Corp. The unit, designed to Navy specifications, employs a self-cooled motor for high ambient temperature operation, and is especially impregnated for humid atmosphere.

32—Connectors are designed for durability

Royal Electric Co., Inc., reports the addition of 3-wire turn-and-pull Royalok polarized caps and connectors to their line of wiring devices. The units



have adjustable cord grips for use with heavy duty, rubber-jacketed service cords. They are UL listed with ratings of 20 amp at 250 v and 10 amp at 575 v, and will fit other standard makes of interlocking devices.

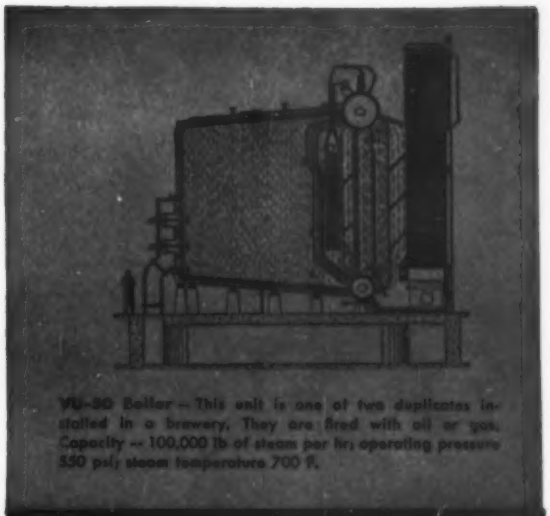
33—Slasher drive provides high efficiency

High efficiency, reduced maintenance and fine control of yarn tension are listed as advantages of a packaged-type multi-motor slasher drive designed by Westinghouse Electric Corp.

Excitation for the d-c generator and drive motors is furnished by a static selenium-type rectifier. All equipment is enclosed in a lint-tight cabinet.

(Continued on page 28)

VU -the choice of Leaders in every Industry



VU-80 Boiler – This unit is one of two duplicates installed in a brewery. They are fired with oil or gas. Capacity – 100,000 lb of steam per hr; operating pressure 550 psi; steam temperature 700 F.

Wherever steam is important for power, heating or process – you'll find C-E Vertical-Unit Boilers (Type VU) establishing new standards of reliable, efficient operation. In industry after industry, leading manufacturers are setting the pace with VU Units.

Food and Beverage companies are typical examples of the widespread acceptance Vertical-Unit Boilers find in industries everywhere. Many of the leading food processors, as shown below, are consistent users of VU Boilers.

But why list only the larger companies, when so many VU Boilers are used in smaller plants? Chiefly because the practices of the big companies form a helpful buying guide. Large companies buy boilers frequently so their experience is always up-to-date. They buy them for different plant locations and for a variety of operating conditions. Thus, they have the accumulated knowledge and broad experience needed to make sound boiler selections.

You can profit from this industry's experience – or from that of any industry that has large steam requirements. So if you need reliable, low-cost steam – from 10,000 to 350,000 pounds per hour – investigate the advanced design ... sound construction ... proved reliability of C-E Vertical-Unit Boilers.

VU-40 Boiler – This unit is installed in the plant of a food product company. It is fired by oil; arranged for future pulverized coal. Capacity – 60,000 lb of steam per hr; operating pressure – 250 psi; steam temp. 600 F.

VU-10 Boiler – This unit, one of three duplicates, is installed in a food processing plant. It is fired by a chain grate stoker. Capacity – 25,000 lb of steam per hr; operating pressure – 125 psi; no superheat.

Leading Food and Beverage Companies using VU Boilers in one or more plants

American Maize Products Co.
American Sugar Refining Co.
Anheuser-Busch, Inc.
Armour & Co.
J. E. Brach & Son, Inc.
Curtis Bros.
General Foods Corp.
H. J. Heinz Co.
Kind & Knox Gelatin Co.
Penick & Ford, Ltd., Inc.
Joseph Schlitz Brewing Co.
W. F. Schrafft's & Sons, Inc.
Spreckels Sugar Co.
Sunshine Biscuits, Inc.
Swift & Co., Inc.
Wm. Wrigley, Jr., Co.

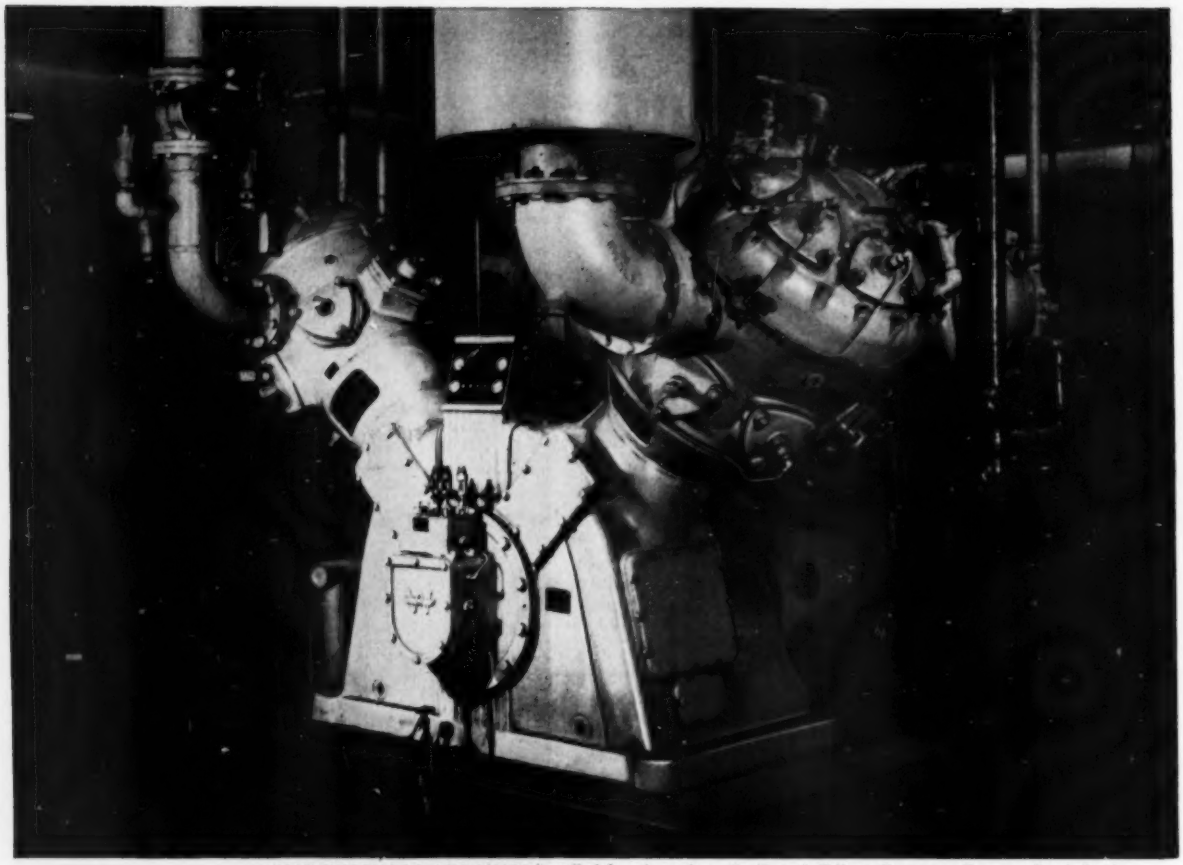
COMBUSTION ENGINEERING – SUPERHEATER, INC.

Combustion Engineering Building • 200 Madison Avenue, New York 16, N. Y.

C-E

S-398A

ALL TYPES OF BOILERS, FURNACES, PULVERIZED FUEL SYSTEMS AND STOKERS; ALSO SUPERHEATERS, ECONOMIZERS AND AIR HEATERS



WORTHINGTON YC-2 COMPRESSOR installed for plant air at the Detroit Edison Company Conners Creek Station.

Why Worthington customers are repeat customers

At Worthington we naturally welcome "repeat" customers.

We do our best to cultivate them by building the most efficient compressors we can. This is particularly true of the YC-2 compressor. No other air compressor offers greater operating savings.

You save installation costs. YC-2 comes completely assembled—no alignment problems, no erecting engineer needed.

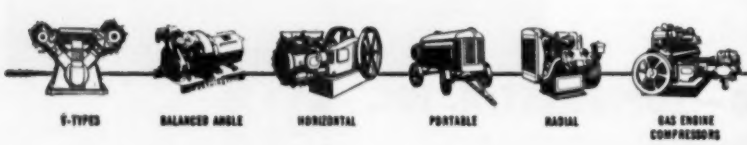
You save power. Worthington Feather® Valve is simplest, lightest, tightest. Maximum number of valves means lower velocities, less friction, and *less power.* 3- or 5-step instantly responsive control matches capacity to the varying amounts of air your shop needs, with lower power consumption at partial load.

You save space. YC-2 requires one-half the space, one-fourth the foundation of horizontal compressors of the same capacity.

You save maintenance. Entire running gear is pressure-lubricated, features anti-friction main bearings.

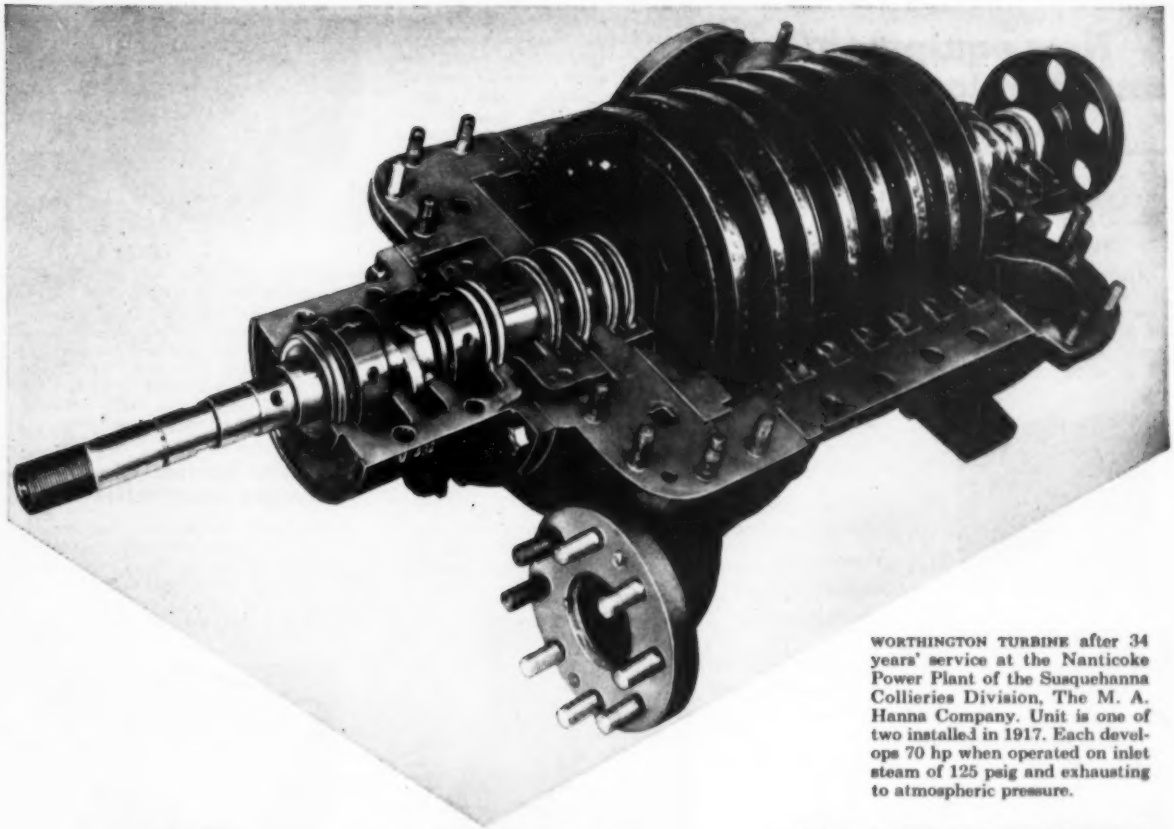
Write for Bulletin L-667B1B. Worthington Corporation, Compressor Division, Buffalo 5, New York.

K.2.11



No Other Compressor Will Outperform a Worthington

WORTHINGTON
Compressors



WORTHINGTON TURBINE after 34 years' service at the Nanticoke Power Plant of the Susquehanna Collieries Division, The M. A. Hanna Company. Unit is one of two installed in 1917. Each develops 70 hp when operated on inlet steam of 125 psig and exhausting to atmospheric pressure.

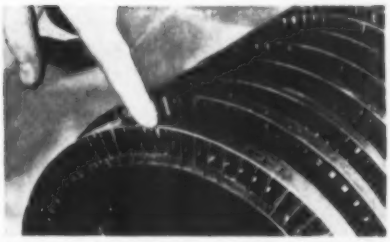
This reconditioned Worthington Turbine has seen 34 years' service

Installed in 1917, this Worthington steam turbine will probably go on to serve the Nanticoke Power Plant of the Susquehanna Collieries Division, The M. A. Hanna Company, for many years to come.

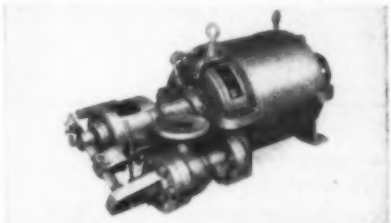
This unit is one of two that for 34 years have been driving induced draft fans—and was recently returned to Worthington's Wellsville, N. Y., plant for reconditioning.

Whether your requirements call for 70 hp or 24,000 hp, the complete Worthington line offers you the right steam turbine for your mechanical drives—a rugged performer that's ready to serve you economically and give you years of uninterrupted service.

Worthington Corporation, Steam Turbine Division, Wellsville, New York.



CLOSE-UP OF TURBINE BLADING shows that, except for a few single insertions, it remains the same as when turbine was installed 34 years ago.



COMPLETE TURBINE—ONE OF THE TWO that have been driving fans for Susquehanna Collieries since 1917.

T-2-3

SINGLE-STAGE TURBINES | MULTI-STAGE TURBINES | TURBINE-GENERATOR SETS | FEED WATER HEATERS | BOILER FEED PUMPS | SURFACE CONDENSERS

A GREAT TEAM IN STEAM

WORTHINGTON

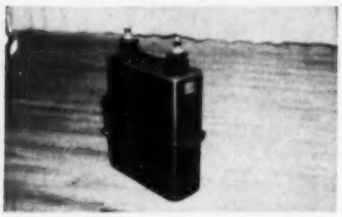
Steam Turbines

New equipment and developments

(Continued from page 24)

34—Capacitor for secondary network systems

General Electric Company's Capacitor Dept. announces a 7.5 kvar capacitor designed for secondary systems of 208 and 216 v, and for occasional high temperatures and submersion



conditions encountered in vaults. It is built for ambient temperatures as high as 55 C.

35—Labels permit quick marking of containers

W. H. Brady Co. offers a solution for labeling containers holding hazardous liquids, as prescribed by state laws. Known as Quick-Label, they are pressure sensitive markers made of strong

cloth and silicone plastic-coated to resist oil and abrasion. Appropriate warnings are clearly printed in black on yellow, and the more common materials are clearly marked. Space is provided for self-sticking inserts which give names of less common materials.

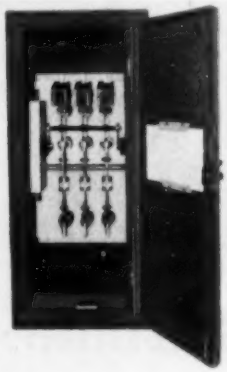
37—Enclosed switch combines functions

Disconnect and load interrupter functions are combined in a metal enclosed Dis-ruptor switch designed by Delta-

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

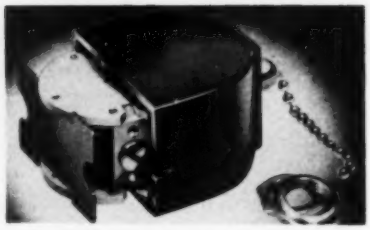
Star Electric Div. of H. K. Porter Co., Inc. for 600 v a-c or d-c. Units are rated 400, 600, 1200, 2000 and 3000 amp for two or three pole service, with or with-



out provisions for high interruptor capacity fuses. Complete information is contained in available literature.

38—Switch for heavy industrial loads

For controlling heavy loads in industrial electrical service, McGill Manu-



facturing Co., Inc. has developed a universal-lever operated pull switch known as the Levolier Model 2020. It will safely carry 2500 w at 125 v, and is said to be the smallest switch of its type and rating. The unit meets all UL requirements including overload and breakdown tests and is fully approved. Design is discussed in a bulletin.

39—Tester provides rugged construction

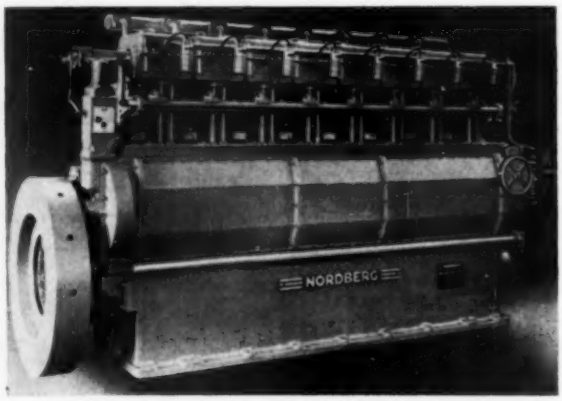
Martindale Electric Co. has designed a volt-ampere-ohm tester, model 52, especially suited for long hard service on the bench or in the field. The unit provides four testing ranges: 0 to 10, 0 to 50, 0 to 250 and 0 to 1000 v a-c and

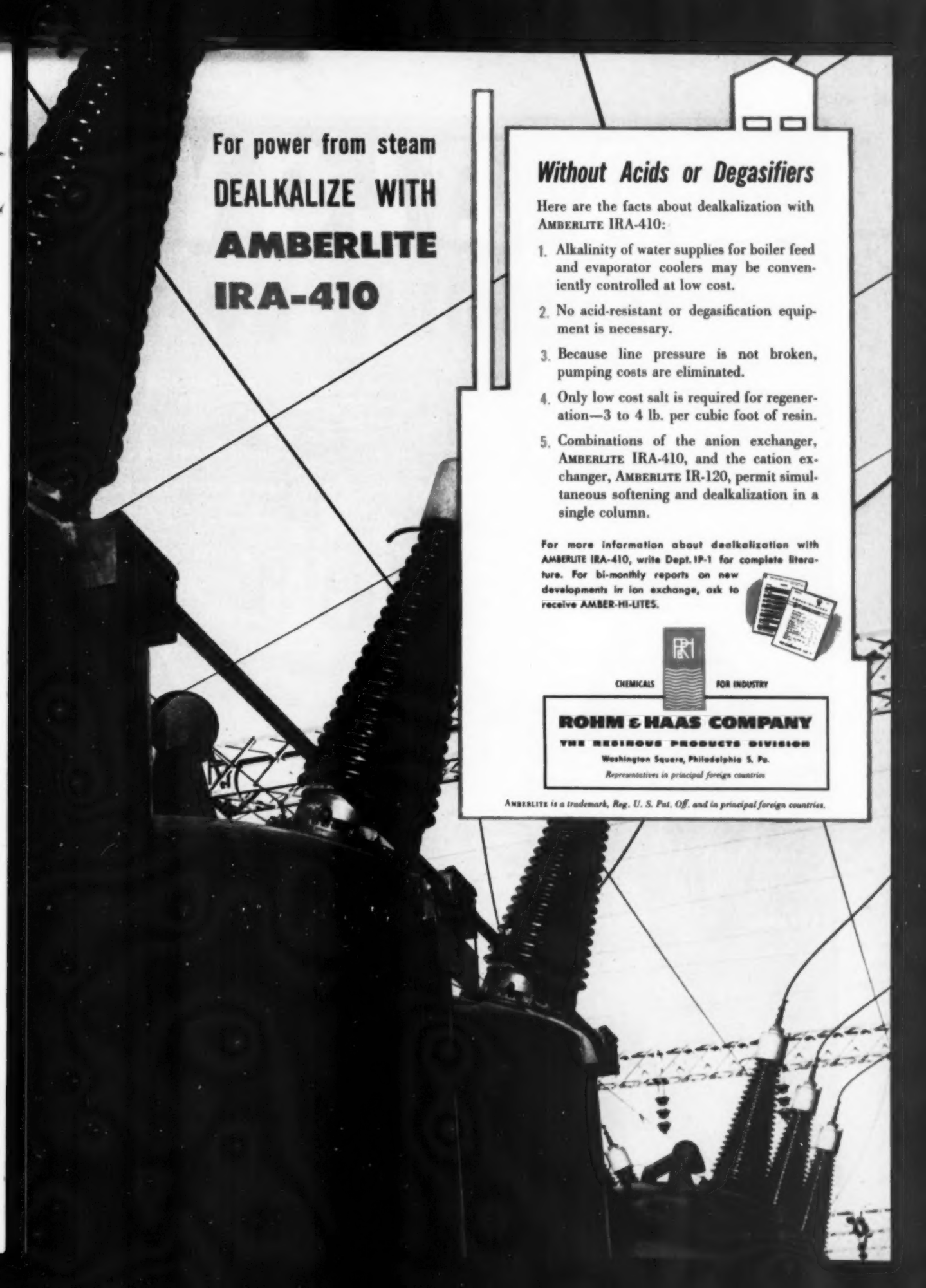
d-c and 0 to 2.5 v a-c only; 0 to 10 amp d-c; 0 to 1000 and 0 to 10,000 ohms; and 0 to 1 and 0 to 100 megohms.

(Continued on page 32)

36—Spark-fired gas engines feature high efficiency

Production of four-cycle spark-fired gas engines is announced by Nordberg Manufacturing Co. Known as types FSE-9 and FSE-13, they are built with 9 and 13 in. bore sizes respectively in non-supercharged, supercharged, intercooled-supercharged and Supairthermal types ranging from 265 to 4260 hp. The engines economically burn natural gas, butane, propane, manufactured gas and sewage gas. Other gases of lower Btu content also can be used, but at reduced ratings. Where gas is available on a seasonable basis, the units can be converted to fuel oil or dual fuel operation. Thermal efficiency is said to range from over 41 per cent with the Supairthermal engine to 38 per cent with the non-supercharged type. According to the manufacturer, the high efficiency is the result of expansion ratios up to 12½ to 1 and controlled air-fuel ratios by variable inlet valve timing. Applications include pipeline pumping service, oil refining and production, industrial and municipal power plants, utilities, sewage plants and oil well drilling rigs.





For power from steam

DEALKALIZE WITH AMBERLITE IRA-410

Without Acids or Degasifiers

Here are the facts about dealkalization with AMBERLITE IRA-410:

1. Alkalinity of water supplies for boiler feed and evaporator coolers may be conveniently controlled at low cost.
2. No acid-resistant or degasification equipment is necessary.
3. Because line pressure is not broken, pumping costs are eliminated.
4. Only low cost salt is required for regeneration—3 to 4 lb. per cubic foot of resin.
5. Combinations of the anion exchanger, AMBERLITE IRA-410, and the cation exchanger, AMBERLITE IR-120, permit simultaneous softening and dealkalization in a single column.

For more information about dealkalization with AMBERLITE IRA-410, write Dept. IP-1 for complete literature. For bi-monthly reports on new developments in ion exchange, ask to receive AMBER-HI-LITES.

CHEMICALS FOR INDUSTRY

ROHM & HAAS COMPANY

THE RESINOUS PRODUCTS DIVISION

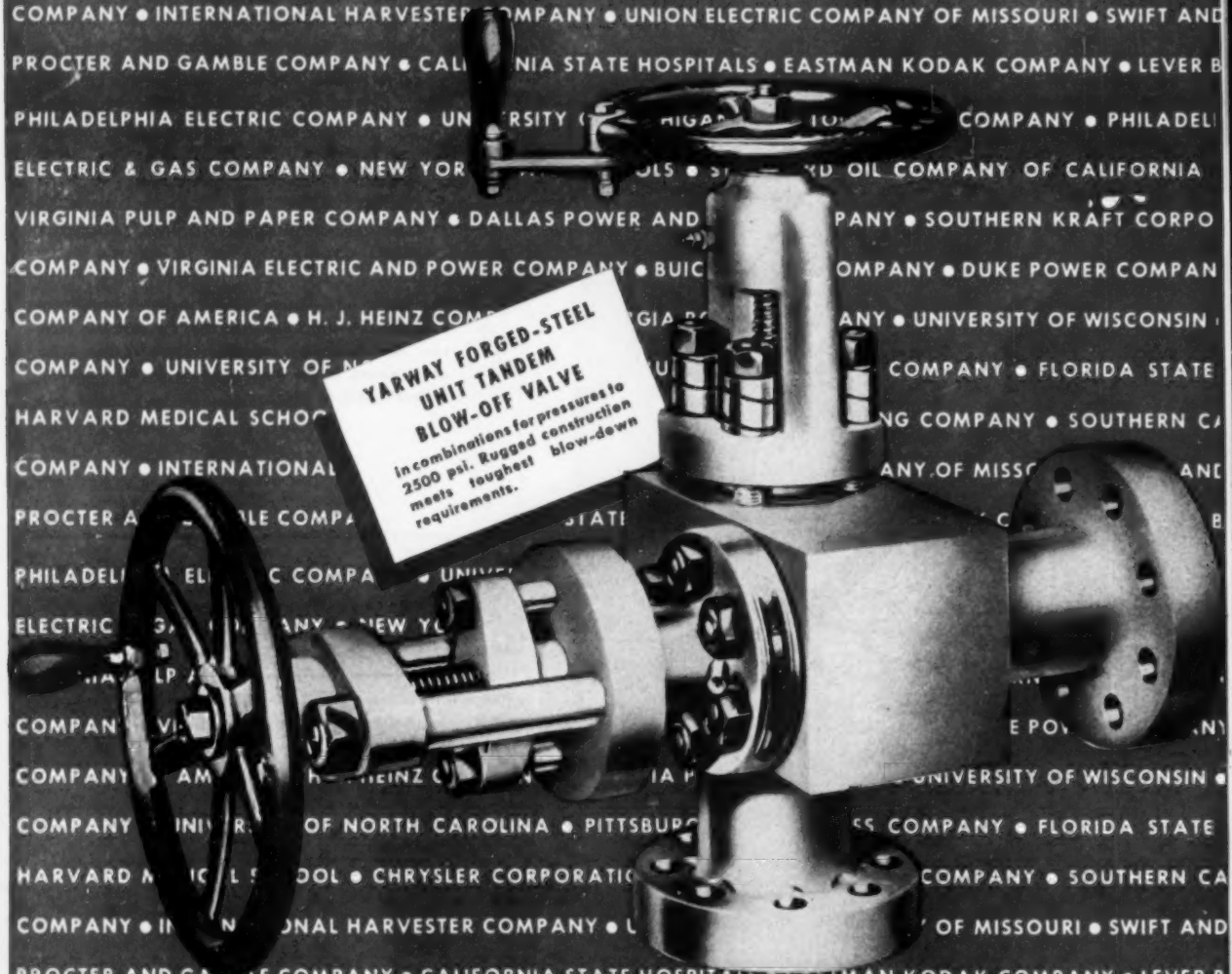
Washington Square, Philadelphia 5, Pa.

Representatives in principal foreign countries

AMBERLITE is a trademark, Reg. U. S. Pat. Off. and in principal foreign countries.

A BLOW-

IS KNOWN BY THE


YARWAY FORGED-STEEL
UNIT TANDEM
BLOW-OFF VALVE
In combinations for pressures to 2500 psi. Rugged construction meets toughest blow-down requirements.

YARWAY

HIA PUBLIC SCHOOLS • PACIFIC GAS & ELECTRIC COMPANY • IOWA STATE COLLEGE • PUBLIC SERVICE
BOSTO S AN LI PA UN EST
RATIO E NY) IC N ER TOR
Y • E.I. MPANY AN C NY UM
R. J. REYNOLDS TOBACCO COMPANY • CARNEGIE INSTITUTE OF TECHNOLOGY • HUMBLE OIL AND REFINING
HOSP M NG NY • SITY T Y •
LIFO E CORPO ATION OF ERI N O ER NO GHT
COMPANY • FLORIDA POWER COMPANY • ARMOUR AND COMPANY • UNIVERSITY OF PENNSYLVANIA •

OFF VALVE BOILERS IT PROTECTS

When buying blow-off valves, weigh the significance of these two facts:

More than 15,000 boiler plants in the United States and other countries are equipped with Yarway Blow-Off Valves . . . Some of them for nearly 40 years. *Among high pressure plants, 4 out of every 5 in the United States are Yarway-equipped.*

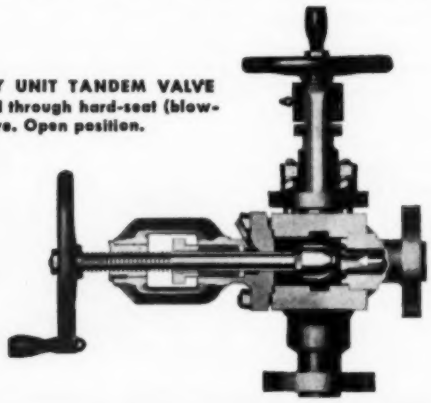
Design, metallurgy, workmanship and service are the reasons. It was Yarway that brought out the famous Seatless Valve, teamed it with a stellited hard-seat valve in a common forged-steel body to make the popular Unit Tandem. Yarway has also made available metallurgical improvements to withstand the chemical reactions of acid wash as well as the mechanical wear of boiler blow-down.

Yarway continues to pioneer and improve blow-off valves and blow-off valve service for both high and low pressure applications.

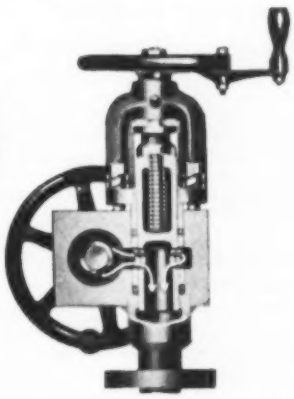
On new boilers, replacements or modernization, make sure you specify Yarway Blow-Off Valves. Any boiler manufacturer will supply them on your specification.

Bulletin B-424 gives you the full story on pressures to 400 psi. Bulletin B-433 for higher pressures. Both are free. Write . . .

YARNALL-WARING COMPANY, 109 Mermaid Ave., Philadelphia 18, Pa.



YARWAY UNIT TANDEM VALVE sectioned through hard-seat (blowing) valve. Open position.



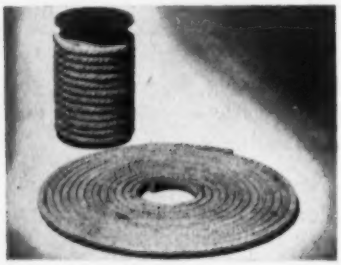
YARWAY UNIT TANDEM VALVE sectioned through seatless (sealing) valve. Open position.

New equipment and developments

(Continued from page 28)

40—Construction of packing provides resiliency

Greater resiliency is said to be imparted to white braided, Teflon impregnated asbestos packing by a new type of construction. The manufac-



turer, Flexrock Co., reports that construction employs a braided or twisted core of Teflon impregnated glass fiber over which is braided several jackets of asbestos yarn thoroughly impregnated with Teflon. The improvement is said to be most pronounced on high speed centrifugal acid pumps, where lack of resiliency causes solid braided Teflon packings to heat up.

41—Switch provides safer instrument servicing

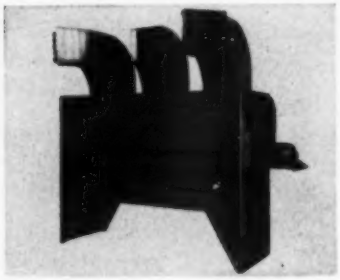
Faster, safer instrument servicing of strip chart Tel-O-Set recorders is possible due to the adoption of a new automatic motor cut-out mercury switch developed by the Industrial Div. of Minneapolis-Honeywell Regulator Co. It is said to eliminate the need for explosion-proof switches and the necessity for shutting down an entire panel, or tapping live wires.

42—Unit recovers coolant oil

Recovery of coolant oil from mist and smoke generated by high speed machining operations is provided by a redesigned Precipitron oil mist control unit manufactured by Westinghouse Sturtevant Div. Two models, type PO-6 and PO-12, provide 600 and 1200 cfm air handling capacity, respectively. Fan motors are three phase, fractional horsepower, ball bearing, prelubricated, totally enclosed, for 220 or 440 v service. The power pack operates on single phase, 115 v.

43—Industrial heaters deliver large volumes

Improved industrial heaters, which deliver large volumes of heated air to large areas which cannot be heated by more conventional methods, have been developed by Westinghouse Electric



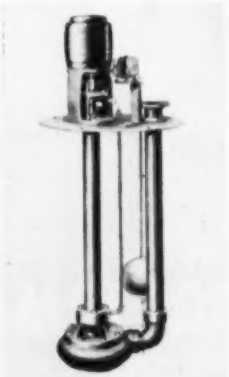
Corp. The self-contained units, which range from 100,000 to 2,500,000 Btu per hr and from 2000 to 25,000 cfm, may be floor, wall or ceiling mounted. They may be mounted in upright or inverted position when wall-mounted.

TO REQUEST ADDITIONAL FREE DATA

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

44—Sewage pumps employ electric or steam drives

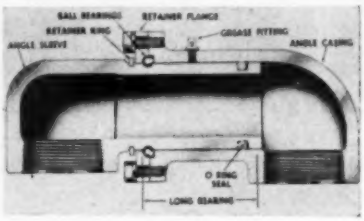
Vertical sewage pumps, developed by The Deming Co., provide fluid ends in 2, 3 and 4 in. sizes designed to han-



dle 1½, 2 and 3 in. diam solids, respectively. Capacities are 50 to 1000 gpm against heads to 60 ft. The impeller is an enclosed, 2-vane, non-clog type, adjustable vertically with shaft. Units can be furnished with electric motors up to 20 hp, or equipped for steam turbine drive. Construction is described in a 4-page bulletin.

45—Swing joints feature improved design

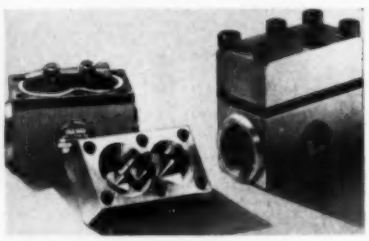
Many design improvements are listed by Barco Manufacturing Co. for ball bearing equipped swing joints developed for loading lines handling such



liquids as oil, gasoline and chemicals. A long lubricated bearing provides adequate support, and ball bearings are positioned to prevent falling out during disassembly. An O-ring is used for sealing. In addition to the single swing style with angle connections, illustrated, other types provide double or single swing, counterbalance, and straight or angle connections.

46—Trap handles large quantities of condensate

Condensate drainage on heat exchangers, reboilers, reheaters and evaporators are a few of the applications listed for the Yarway series 50 impulse steam trap. The manufacturer, Yarnall-Waring Co., states it is a companion to their series 60 and 120 traps. It has been developed for use where unusually large quantities of conden-



sate must be handled. Descriptions and specifications are presented in an available bulletin.

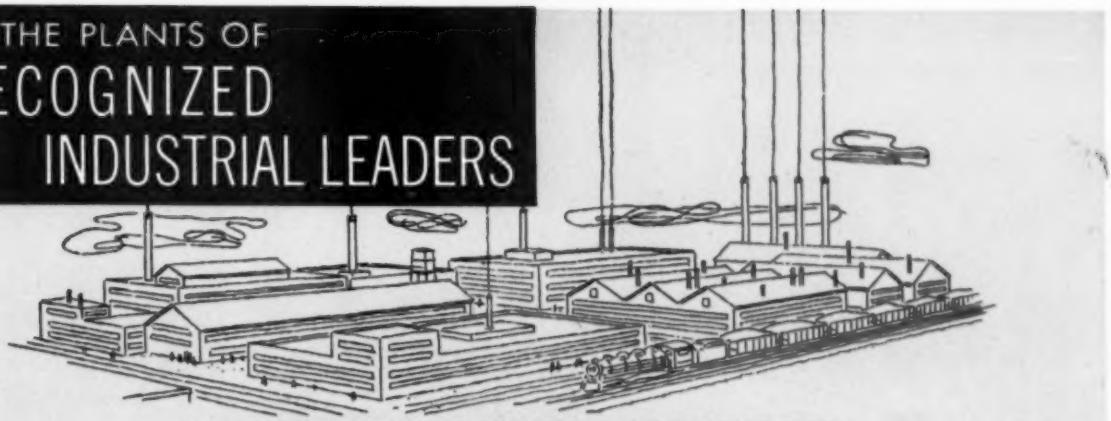
47—Deaerating heater for smaller boiler plants

Graver Water Conditioning Co. has developed a package type deaerating heater for use in the smaller boiler plants. The unit is equipped with all accessories including overflow level control, thermometers, relief valve and vent valve. The unit employs a spray-tray type heater and vent condenser. A vertical type provides 2 min storage, while a horizontal type gives 10 min storage. Standard sizes are for capacities to 100,000 lb per hr.

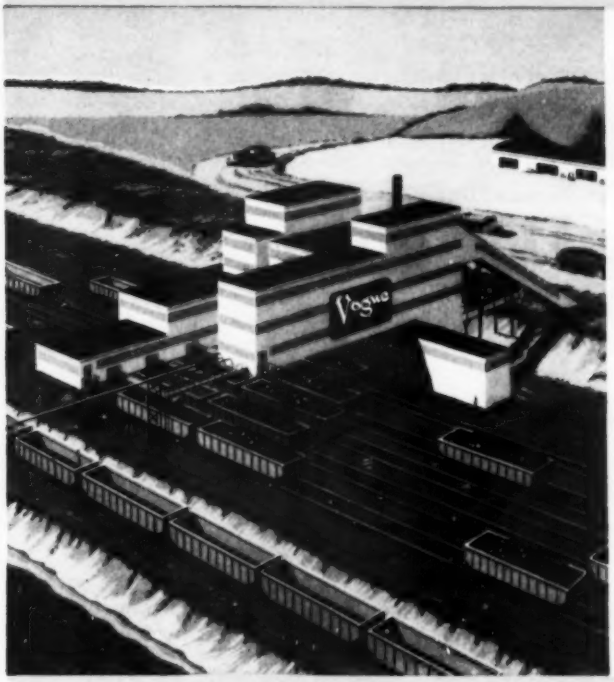
—End

IN THE PLANTS OF

RECOGNIZED INDUSTRIAL LEADERS



—such as the **NATIONAL CASH REGISTER, CATERPILLAR TRACTOR, CENTRAL FIBRE PRODUCTS, LOUISVILLE CEMENT AND BRIGGS MANUFACTURING COMPANIES, SOUTHERN'S** engineered industrial coals are a material factor in economical plant operation. They are representative of the wide selection available from **SOUTHERN'S** extensive, completely mechanized operations in Ohio, Western Kentucky, Indiana, Illinois and Alabama. Typical is this big, modern Vogue Mine in Western Kentucky.



SOUTHERN'S *UNIFORM QUALITY COALS—HELP MAINTAIN ECONOMICAL BALANCE BETWEEN FUEL AND PRODUCTION COSTS* - - - - - - - - - - - - -

Right coal application in your power plant — as in all industries, is an important factor in lowering steam and production costs.

— SOUTHERN'S comprehensive coal service, including a staff of experienced combustion engineers will help you.

Based on thorough equipment analysis, SOUTHERN'S recommendations are specific to your requirements, and proved by burning tests in your boilers. Their soundness is continuously being demonstrated in the boiler rooms of all types of industry through improved combustion, better coal utilization, lower steam costs and substantial fuel economies.

Let SOUTHERN help *you* make such savings. They offer an outstanding selection of thoroughly washed, precision sized and laboratory tested coals. Engineered to rigid industrial specifications for quality, uniformity and freedom from impurities, they give you the added long term insurance of dependable supply — 10,000,000 tons annual capacity from 16 modern coal mines.

STORE YOUR COAL SAFELY — ECONOMICALLY

READ THIS HELPFUL BOOKLET

Written by Joseph Harrington—one of America's foremost combustion engineers and authorities on Coal; its history, chemistry, properties, preparation; and efficient utilization, storing and handling.

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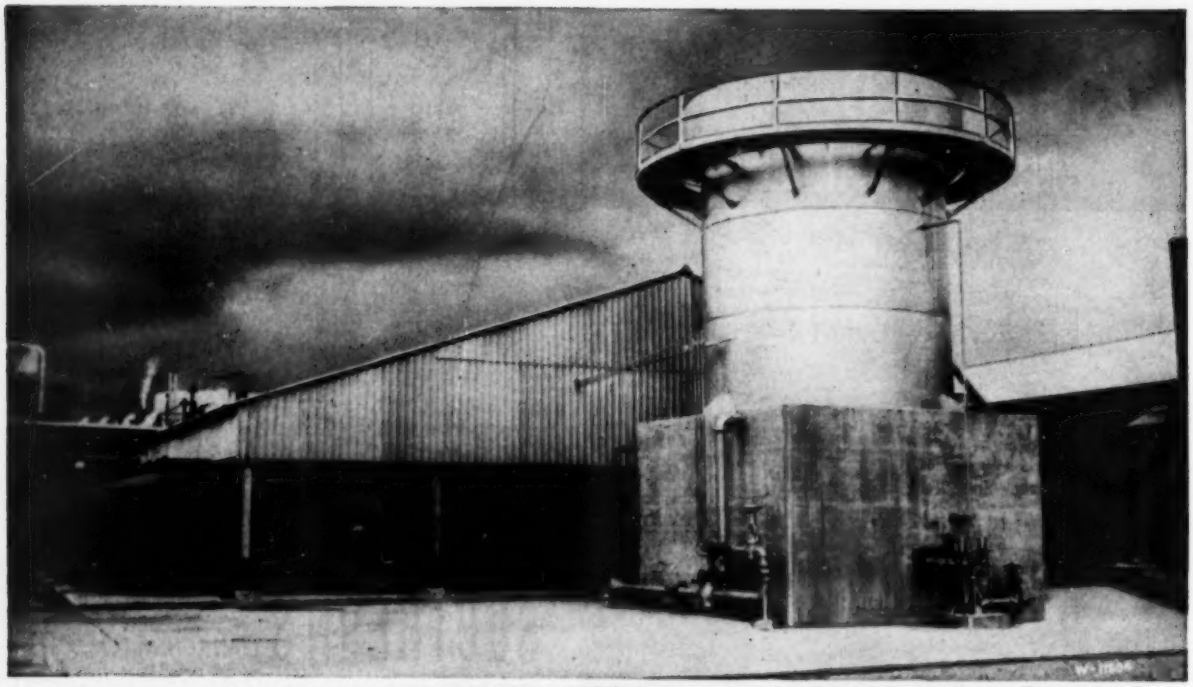
YOU CAN RELY ON SOUTHERN'S ENGINEERED INDUSTRIAL COALS

Southern Coal Company, Inc.

MEMBER BITUMINOUS COAL RESEARCH, INC.

GENERAL OFFICE 333 NORTH MICHIGAN AVENUE, CHICAGO 1, ILLINOIS • OFFICES IN LOUISVILLE, MEMPHIS, NASHVILLE, ST. LOUIS

SINCLAIR COAL COMPANY KANSAS CITY 6, MO. WESTERN REPRESENTATIVE



SPECIALLY DESIGNED 500 GPM WORTHINGTON TREATING SYSTEM at the new Pemex natural gas refinery in Poza Rica, Mexico. System includes cold-process slurry-type softener followed by acid feed, filtration and zeolite treatment. Engineered by Arthur G. McKee Company.

Specially Designed for Intermittent Service

Softening system for boiler feed water built for short-period operation, long shutdowns

Water conditioning requirements are especially tough at the new Pemex natural gas refinery in Poza Rica, Mexico.

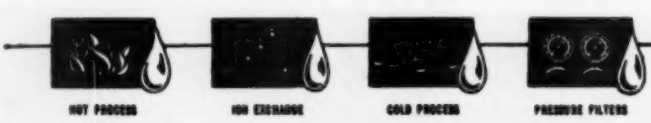
Their need for variable-rate, continuous-service softener operation is complicated by the intermittent boiler feed-water storage demands.

Pemex's conditioning requirements have been met by a specially built Worthington system, so designed that the slurry bed is not lost during "off-service" periods. The bed resumes its normal suspended position at the instant service is resumed. This avoids the irregular treatment, delay and water waste common in systems that require creation of a new slurry bed after each shutdown period.

New Bulletin W-212-B5 gives you the vital facts about this unique cold process water softening method. Write for your free copy today.

Worthington engineers and builds equipment for all the major types of water-conditioning systems, therefore is in an excellent position to give comprehensive and well-balanced recommendations on your water-conditioning equipment problems . . . further proof that *there's more worth in Worthington*. Worthington Corporation, Water Treating Section, Harrison, N. J.

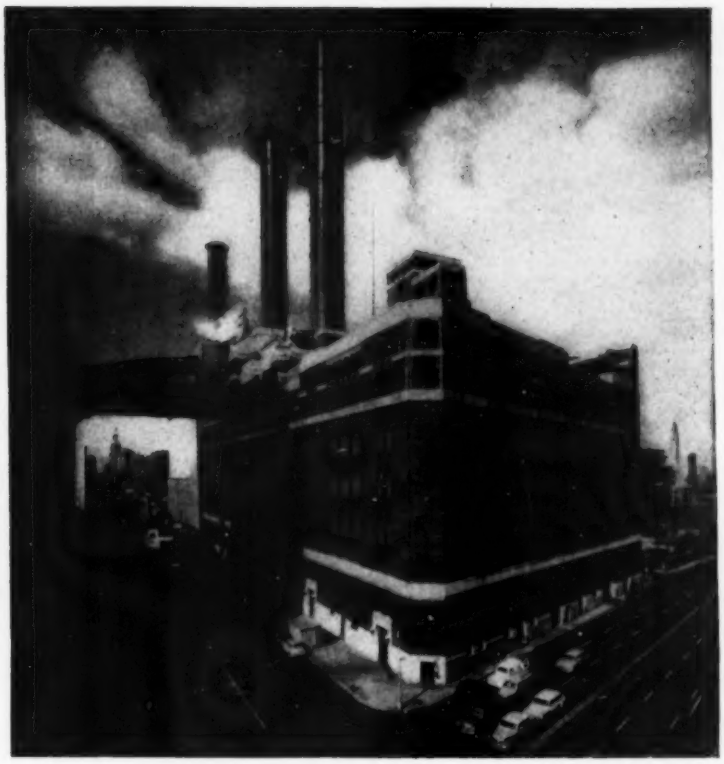
J.1.3



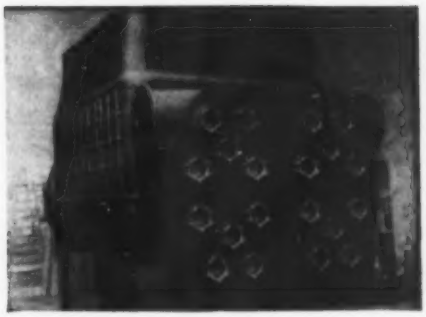
Worthington Makes More of the Equipment for ALL Types of Water Conditioning Systems

WORTHINGTON

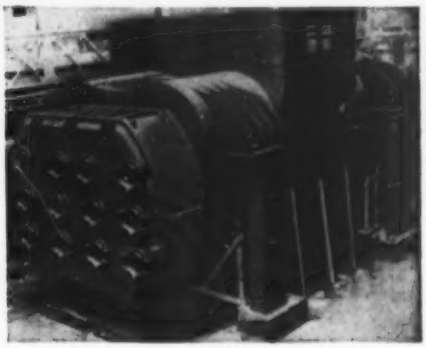
Water Conditioning



CON EDISON'S EAST RIVER ELECTRIC GENERATING STATION at 14th Street, New York City, will contain the new Worthington 125,000 sq-ft condenser. The shell, which is to be installed under 160,000-kw Unit No. 7, will contain nearly 105 miles of ¾" O.D. aluminum brass tubes and will require 138,000 gpm of East River water supplied by two 54 in. Worthington "Mixflo" vertical single suction volute circulating pumps.



WORTHINGTON CONDENSER installed in 1931 to serve 160,000-kw Unit No. 7, Hudson Avenue Station. Tube sheets were drilled for 110,000 sq ft with 101,000 sq ft installed.



ONE OF TWO 74,500 SQ-FT 2-PASS WORTHINGTON CONDENSERS serving 60,000-kw Units 14 and 15 at Waterside Station No. 1.

Con Edison once again installs "largest" condenser

On several occasions over the past fifty years, Worthington has been selected to build the "world's largest" surface condensers in single shell design.

In 1919, a 70,000 sq-ft condenser was installed under a 35,000-kw turbine-generator for a prominent utility company. This was the largest single shell surface condenser of its day.

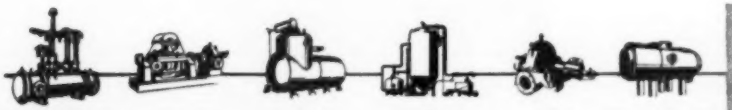
In 1931, Brooklyn Edison Company (now Consolidated Edison Company of New York, Inc.) installed, under 160,000-kw Unit No. 7 at the Hudson Avenue Station, the "world's largest" at that time, a 101,000 sq-ft single-pass Worthington condenser. This was followed, in 1949, by two 74,500 sq-ft condensers for Waterside Station No. 1.

Now, Worthington is again building for Con Edison the "world's largest" single-shell condenser ever ordered, 125,000 sq-ft, single-pass, for the 160,000-kw Unit No. 7 addition to East River Station.

Worthington, with over a century of experience in the manufacture of steam power equipment, is prepared to build efficient condensers in all sizes. Let us advise you, without obligation, on your new installation.

Write, stating requirements, to *Worthington Corporation, Steam Power Division, Harrison, New Jersey.*

Z.2.2



World's Broadest Line of Steam Power Plant Auxiliaries

WORTHINGTON

Condensers

G-E Hook-on Volt-ammeter Stays Accurate

STURDY DESIGN AND HEAVY-DUTY PARTS ASSURE DEPENDABILITY AND LONG LIFE

Shock-proof construction, built-in magnetic shielding (from fields of adjacent conductors), and temperature-compensated circuits are only three of the many features of this new G-E hook-on that help assure you of sustained accuracy. Strong dovetail joint in the transformer makes errors caused by imperfect closing practically negligible. The convenient and reliable range-selector switch provides positive range switching—enables you to make current or voltage readings quickly and simply.

OTHER NEW FEATURES

A new, easily adjusted pointer-stop mechanism simplifies reading motor-starting currents. In addition, this versatile hook-on has five current scales ranging from 7.5 to 750 amperes; three voltage ranges are 0-150/300/750 volts. Accuracy for all readings is 3%—even on low current ranges.

ONE-HAND OPERATION

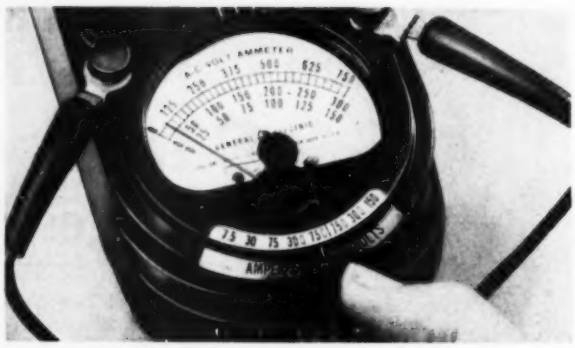
Current is measured by simply hooking the jaws of the instrument around the line. Voltage readings can be made by attaching the extra large alligator clips across the line. A flick of the selector switch gives you the desired full scale; and current readings can be taken without removing the potential leads.

NOW AVAILABLE

See this newest member of the G-E hook-on family today at your nearest G-E apparatus distributor. No increase in price over the previous model: $66.75*. General Electric Company, Section 602-246, Schenectady 5, N. Y.

*Manufacturer's suggested retail price.

GENERAL ELECTRIC



ADDED RANGES: New higher and lower current ranges (0-7.5/30/75/300/750 amperes) and higher voltage range (0-150/300/750 volts) can be quickly selected with the handy selector switch.

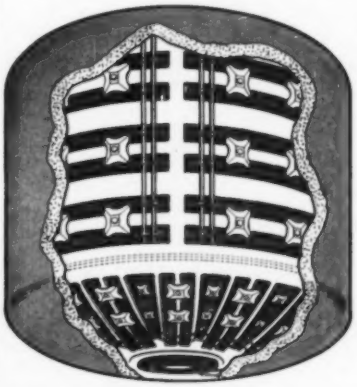
NEW POINTER STOP makes reading of motor-starting currents easy. Using one finger, set stop until pointer barely deflects: the scale reading will then indicate motor-starting current.

Industry's Most Versatile Heat Source

Chromalox *Electric* Strip Heaters

Easy to Install CHROMALOX Electric Strip Heaters give clean, dependable and accurately controlled heat where and when heat is needed. They produce uniform and accurate temperatures by automatic or manual controls. Low initial costs, low installation costs and low operating costs are among the many advantages of using CHROMALOX Strip Heaters for heating liquids, gases, viscous fluids, tanks, platens, molds, moving parts, etc. Get the full details now.

A Typical Strip Heater Application from Our Files



Rugged, easily installed Chromalox Strip Heaters assure accurate temperature, dependable around-the-clock service.

Strip Heaters curved lengthwise at the factory fit snugly to tank perimeter and

Strip Heaters curved slightly as installed conform to shape of convex kettle bottom, while

Segment Heaters fill the gaps.

IC-99

CHROMALOX

Electric Heat for Modern Industry

Sizes, Types and Sheaths for Every Need
LENGTHS
4" to 96" lengths, 1" to 2½" widths; rings 2½" to 11" diameter. 115 to 460 volts
CURVES & SEGMENTS
Curved in cross section or formed lengthwise to desired radii
TERMINALS
Varied terminal types for convenient wiring. 2 terminals at one end, centered, or at opposite ends. 3 terminals at same end of the unit
SHEATHS
Rust-resisting iron, high temperature steel and Monel sheaths to meet exact service conditions

Want Ideas?

on how to use Chromalox Electric Heaters in your plant

Write for the data-packed Catalog 50 which describes many types of Chromalox Electric Heaters and how to apply them. It's yours without obligation.

EDWIN L. WIEGAND COMPANY
7520 Thomas Blvd., Pittsburgh 8, Pa.

New G-E Boiler-feed-pump Motor

A true power station motor from top to bottom, General Electric's new Boiler-feed-pump Motor offers you many features—among them:

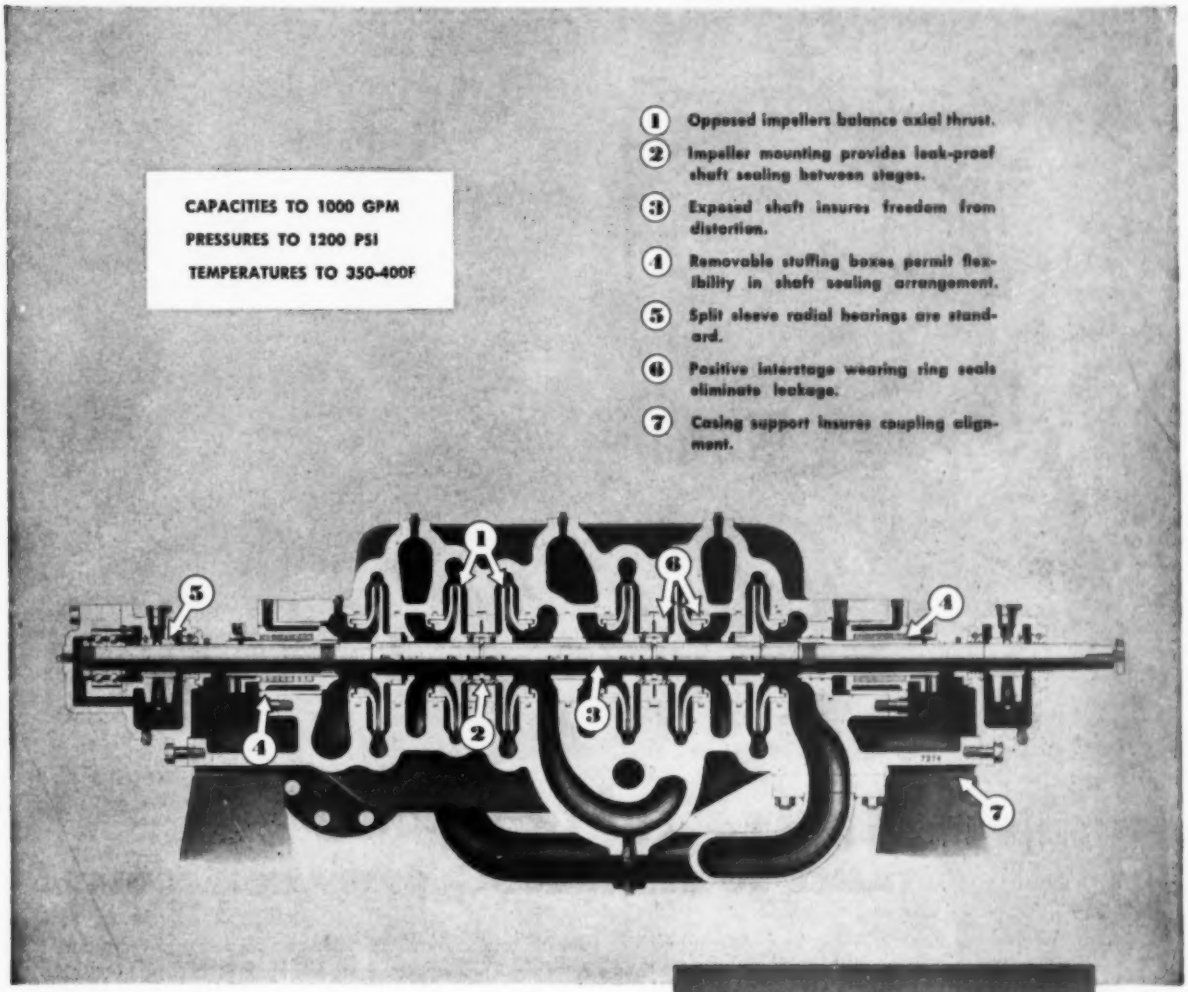
- **Cubical shape reduces width.**
- **Air discharge out top permits mounting motors closer together, improves employee comfort.**
- **Streamlined rotor improves performance—is quieter.**
- **Modern appearance blends with power station styling.**

For more complete information, ask your G-E representative for Bulletin GEA-5813, or write Section 753-1, General Electric Company, Schenectady 5, N. Y.

You can put your confidence in—

GENERAL ELECTRIC

Simplicity, long life, easy maintenance


CAPACITIES TO 1000 GPM
PRESSURES TO 1200 PSI
TEMPERATURES TO 350-400F
1 Opposed impellers balance axial thrust.
2 Impeller mounting provides leak-proof shaft sealing between stages.
3 Exposed shaft insures freedom from distortion.
4 Removable stuffing boxes permit flexibility in shaft sealing arrangement.
5 Split sleeve radial bearings are standard.
6 Positive interstage wearing ring seals eliminate leakage.
7 Casing support insures coupling alignment.

You get them all with...

DE LAVAL
OPPELLER PUMPS

Look at the seven outstanding features shown in the cross-section and you'll see why De Laval Boiler Feed Pumps stay on the job for years...trim maintenance costs. Suitable materials are available for all water conditions. Write today for bulletin giving full application and specification data.

DE LAVAL *Boiler Feed Pumps*

DE LAVAL STEAM TURBINE COMPANY
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DL 148

STOPS SHAKES...PUTS PURR-R-R IN POWER

PENFLEX TUBING

TAMES POWER THROB . . . OPERATION COOLER

When two large diesels roar into action, there can be plenty of vibration transmitted to all points. This was true on one installation . . . engine vibration created a regular power throb.

The answer was found in a length of Penflex four wall interlocked air jacketed exhaust tubing on each exhaust. The flexibility of the tubing absorbed the vibration . . . put a purr in power. At the same time it achieved a circulation of air and efficient cooling action . . . prevented breakage due to thermal expansion.

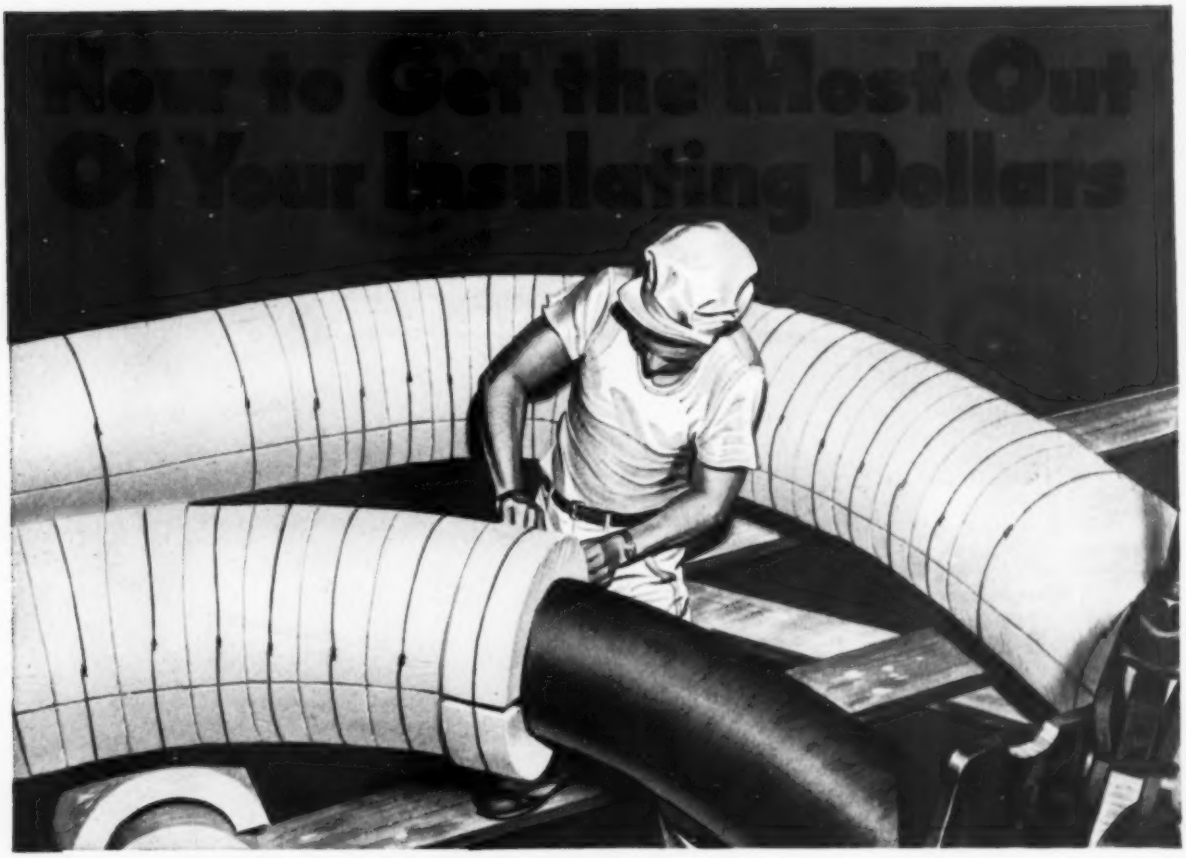
Whether your problem is vibration of exhaust lines or air lines . . . the transmission of liquids, volatiles, granular material or coarse abrasive products, Penflex engineers will be glad to work with you in the application of tubing from ⅛" I.D. on up. Penflex also manufactures barrel fillers, pneumatic rivet passers and a complete line of accessories and fittings.

Get your copy of this folder on "Flexineering."

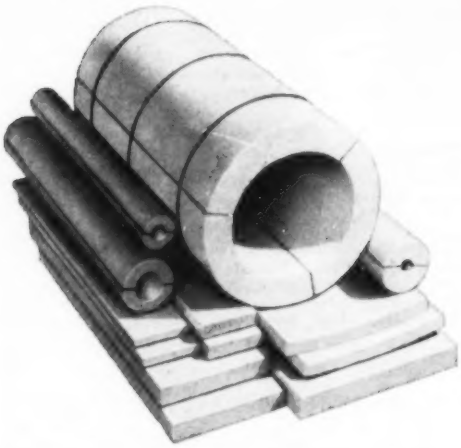
Pennsylvania Flexible Metallic Tubing Company, Inc., 7238 Powers Lane, Phila. 42, Pa.
Branch Sales Offices: Boston • New York • Chicago • Houston • Cleveland • Los Angeles

PENFLEX

HEART OF INDUSTRY'S LIFE LINES



The Right Material . . . Expert Application



First, Kaylo Heat Insulation is *proved* a *better* material—hydrous calcium silicate. Its light weight, strength, water-insolubility, low conductivity and wide temperature range give you extra advantages *at no extra cost.*

Second, Kaylo distributors have the technical knowledge and experience to provide you with a complete insulating service. Their trained applicators are skilled craftsmen who do neat and efficient installation.

To be *sure* of getting the most out of your insulating dollars for your next job, call the nearest Kaylo distributor. Chances are you can find him listed in the yellow pages of your phone book. If not contact us and we'll give you his name.

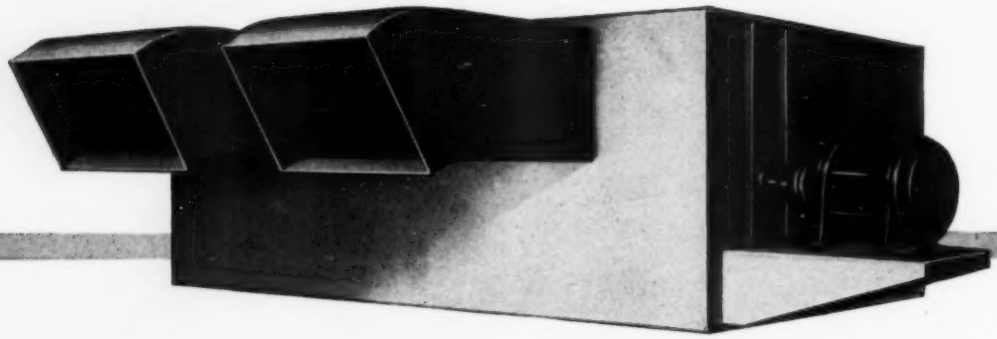
WRITE FOR FREE BOOK—"Kaylo Heat Insulation." Address: Dept. N-406, Owens-Illinois Glass Company, Kaylo Division, Toledo 1, Ohio.

KAYLO® ***. . . first in calcium silicate***

. . . pioneered by OWENS ILLINOIS **Glass Company**

MAIN OFFICE: TOLEDO 1, OHIO—KAYLO SALES OFFICES: ATLANTA • CHICAGO • HOUSTON • NEW YORK • PHILADELPHIA • PITTSBURGH • ST. LOUIS

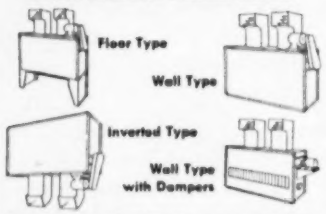
Here's why Trane Torridors can be tailored to fit so many heating jobs!



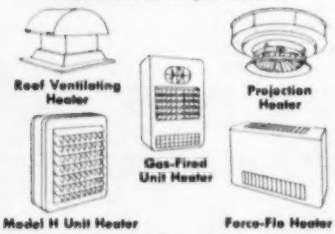
These *standard* TRANE accessories can be combined with any *standard* TRANE Torridor to solve any heating, ventilating, air filtering or process problem.

- **Many coil types . . .**
  High or low pressure steam—Hot water —Standard or "non-freeze" SD type
- **20 Nozzle arrangements**
- **Wide choice of filters and frames**
- **Two types of by-pass dampers**
- **Mixing and intake boxes**

4 More Standard Torridor Models



And 5 Trane Unit Heaters for spot heat where and when you need it.



How you can have Engineered Heating to solve problems like these with a standard TRANE Torridor!

1. Drafty doorways. Use basic Torridor heating section with nozzles and door switch. Positive blanket of heat every time door opens.

2. Negative pressure. Use Torridor with SD "non-freeze" coils and filter section to introduce fresh tempered air. Maintain positive pressure. Eliminate cold air leaks.

3. Close temperature control. Use Torridor with face-and-by-pass and/or modulated steam distributing coils. Tempers chilly morning air . . . permits mild midday air to enter without overheating.

4. Explosive atmosphere. Use Torridors with spark-resistant fans and explosion-proof motors. Many other variations available.

5. Need for quick warm-up. Use mixing box on Torridor. Fresh air dampers close for quick warm-up—modulate to mix ventilation air with room air.

6. Process heating or drying. Torridor has ample room for three rows of high output coils for process heating or drying applications.

7. Compact central system. The powerful centrifugal fans of the Torridor can deliver large quantities of air through duct systems.

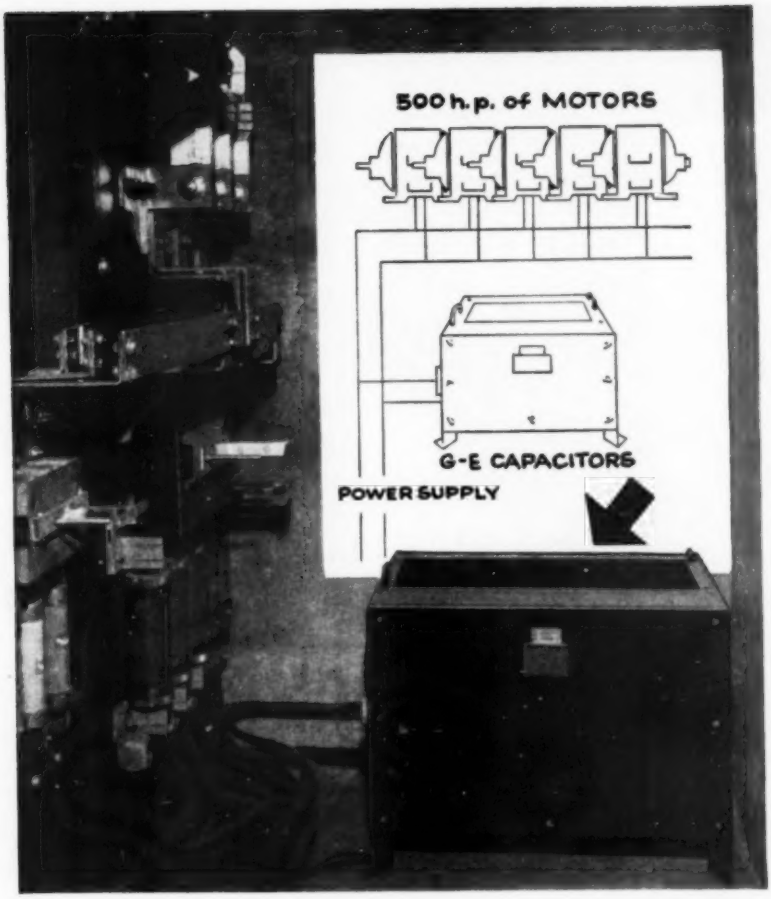
8. Ventilation. Use Torridors for ventilation all year. In the summer, Torridors circulate outside air. In the winter, tempered air.

Problems of fog removal, ice melting, drying, curing and many others can be solved with TRANE Torridors . . . automatically, with standard pneumatic or electrical controls. See your consulting engineer or TRANE office. Write TRANE, La Crosse, Wis., for Bulletin DS-327A.

TRANE Torridors

The Trane Company, La Crosse, Wisconsin • East. Mfg. Div., Scranton, Pennsylvania
Trane Company of Canada, Ltd., Toronto • 80 U.S. and 14 Canadian Offices

TRANE—MANUFACTURING ENGINEERS OF HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT.



Low power factor was penalizing a West Coast meat packing plant until G-E engineers recommended the installation (arrow) of a 60-kvar, 3-phase 60-cycle, 460-volt G-E capacitor equipment.

$355 investment saves up to $47 every month!

WEST COAST MEAT PACKING PLANT INSTALLS GENERAL ELECTRIC CAPACITORS AND CUTS POWER COSTS

Induction motors caused low power factor. Because it takes about 500 hp of induction motors to run a plant that processes between 1500 and 2000 head of beef a day, a West Coast packing plant had a power factor that seldom got above 81%. Rebates on the plant's power bill were down to about $3 a month.

Power factor raised from 81% to 96%. Then G-E engineers recommended the installation of 60 kvar of G-E capacitors at a total cost of $355*. After the capacitors were installed the power factor rose to better than 96% and stayed there. Rebates on the power bill now average between $45 and $50 every month. Thus, in less than nine months, the company realized a saving greater than the cost of the capacitor equipment. ***And these monthly savings will go on indefinitely.***

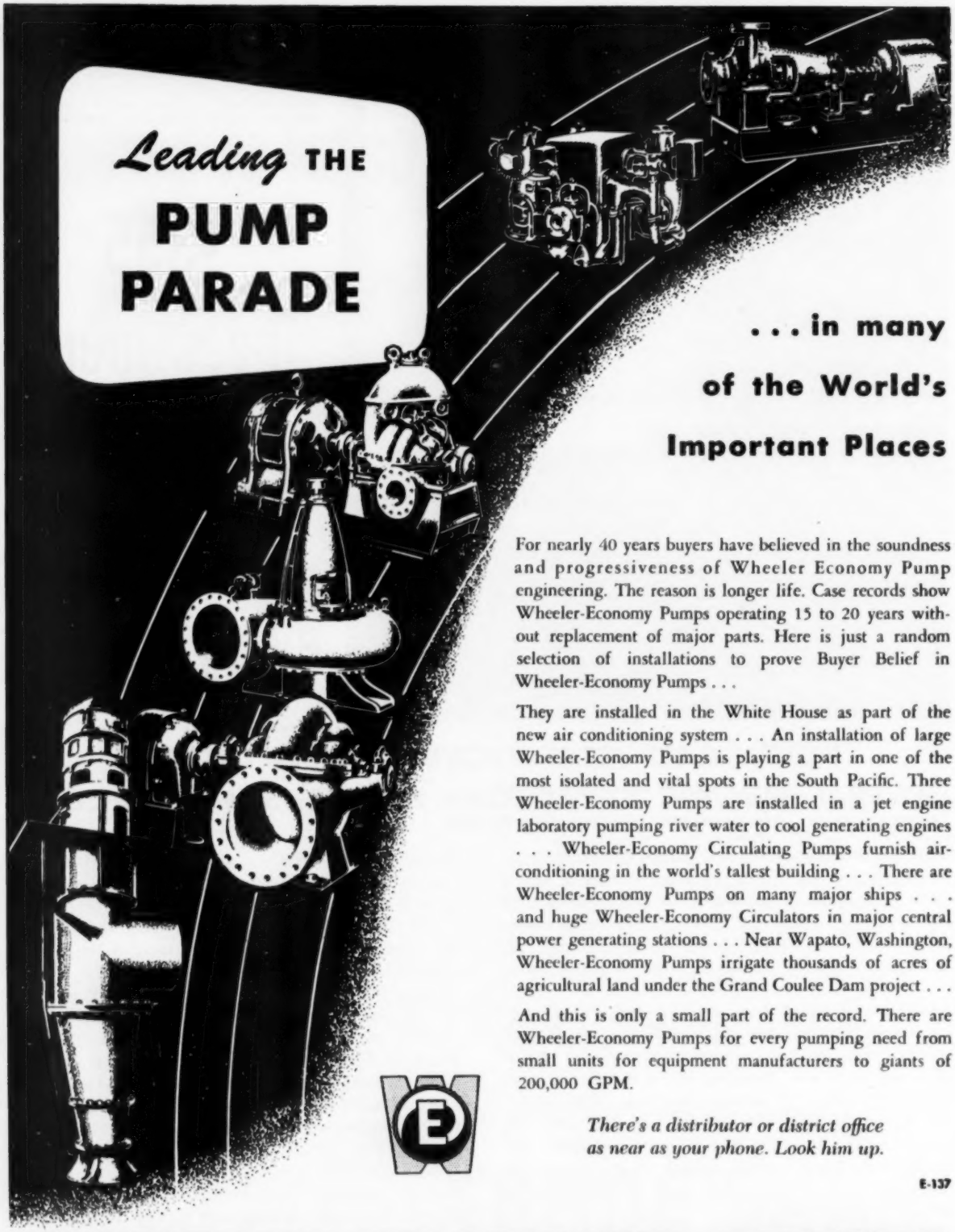
*Cost of capacitor equipment in 1949. Prices slightly higher now.

Capacitors can help in other ways, too! Besides raising power factor, capacitors often permit your present distribution system to carry 20 to 30% more load without added equipment. Where voltage drop is a problem, capacitors can also provide the needed voltage boost inexpensively.

They're the key to lower power costs. This West Coast plant is just one of the many that are cutting power costs with capacitors. If your power factor is below 85% and if there is a power-factor or kva-demand clause in your power contract, chances are you can make similar worth-while savings. Your local G-E sales office or authorized G-E agent or distributor can help you—or write to Section 407-207 for booklet GEA-5632—"How to Use Capacitors to Reduce Power Costs and Gain System Capacity." *General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

407-207



Leading THE
PUMP
PARADE

. . . in many
of the World's
Important Places

For nearly 40 years buyers have believed in the soundness and progressiveness of Wheeler Economy Pump engineering. The reason is longer life. Case records show Wheeler-Economy Pumps operating 15 to 20 years without replacement of major parts. Here is just a random selection of installations to prove Buyer Belief in Wheeler-Economy Pumps . . .

They are installed in the White House as part of the new air conditioning system . . . An installation of large Wheeler-Economy Pumps is playing a part in one of the most isolated and vital spots in the South Pacific. Three Wheeler-Economy Pumps are installed in a jet engine laboratory pumping river water to cool generating engines . . . Wheeler-Economy Circulating Pumps furnish air-conditioning in the world's tallest building . . . There are Wheeler-Economy Pumps on many major ships . . . and huge Wheeler-Economy Circulators in major central power generating stations . . . Near Wapato, Washington, Wheeler-Economy Pumps irrigate thousands of acres of agricultural land under the Grand Coulee Dam project . . .

And this is only a small part of the record. There are Wheeler-Economy Pumps for every pumping need from small units for equipment manufacturers to giants of 200,000 GPM.

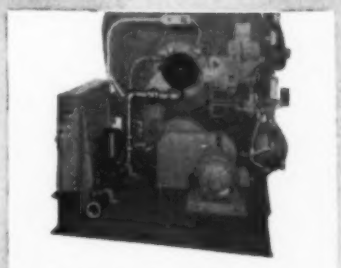
There's a distributor or district office as near as your phone. Look him up.

E-137

WHEELER-ECONOMY PUMPS

ECONOMY PUMPS, INC. - DIVISION OF C. H. WHEELER MANUFACTURING CO.
19TH AND LEHIGH, PHILADELPHIA 32, PA.

unmatched Flexibility of operation ...and of quick fuel change-over



Combination burner for gas or oil. Oil burner shown in stand-by position for quick change-over.

The Modern **Cleaver-Brooks** Model LR Steam Boiler Equipped with the C-B Rotary Burner

✓ **Quick Steaming—Fast, effortless response to fluctuating steam demands**

✓ **Equally high efficiency using heavy No. 6 oils (or lighter oils) and all types of industrial gas**

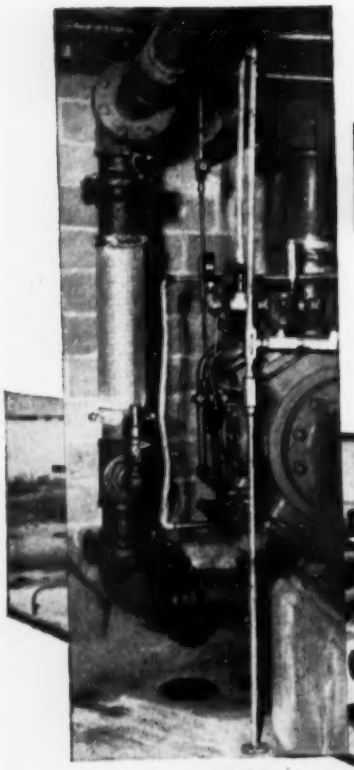
IF the quantity of steam required in your plant fluctuates throughout the day, depending upon the amount of steam-using equipment in operation, you can cut your steam costs substantially with a Cleaver-Brooks Boiler. It operates a full 80% guaranteed efficiency whether you require maximum load use of all steam-using equipment . . . or whether your equipment is not in use, requiring as little as 30% response—often just enough to heat the plant.

Install a Cleaver-Brooks Boiler — oil, gas, or combination — either fuel properly proportioned by the exclusive Cleaver-Brooks Burner to meet your fluctuating or constant steam demand. Fully automatic, clean, with a single source for all of its matched parts . . . you benefit with lower fuel bills, less maintenance, reduced operating costs, greater profits. Why not consider changing your present boiler plant and think of flexibility — remember Cleaver-Brooks and get the complete facts on boilers, 15 to 500 HP — 15 to 250 lbs. psi.

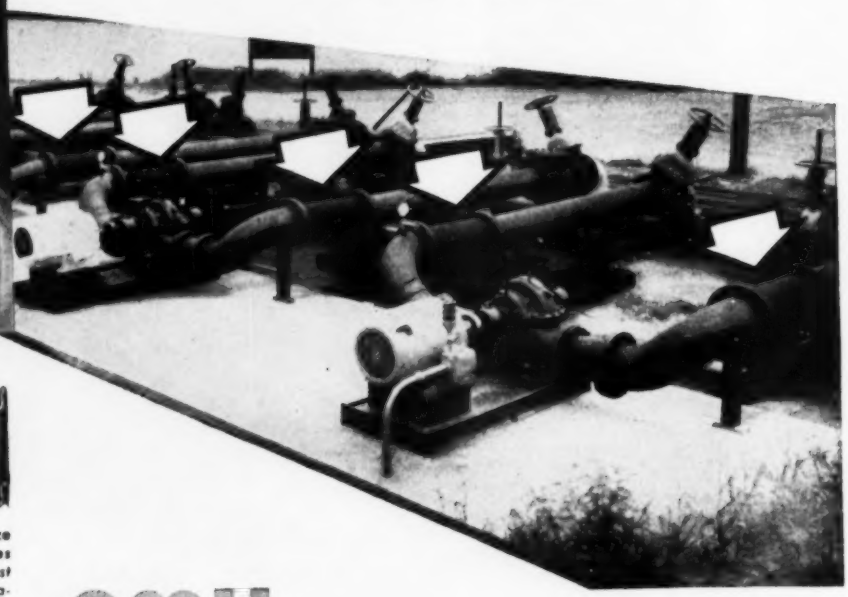
Write for latest, fully illustrated and descriptive Cleaver-Brooks Steam Boiler catalog.

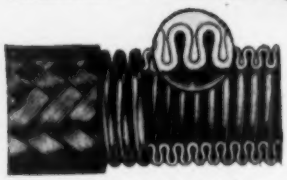
Cleaver-Brooks
STEAM BOILERS
the first and finest of their class

CLEAVER-BROOKS COMPANY
Dept. B-302 E. Keefe Ave., Milwaukee 12, Wis., U.S.A.
Cable Address: Clebro-Milwaukeewis
Builders of Equipment for the Generation and Utilization of Heat • Steam Boilers • Oil and Bitumen Tank-Car Heaters • Distillation Equipment • Oil and Gas-Fired Conversion Burners



Here's the
ECONOMICAL WAY
to keep vibration out of rigid piping . . .





CMH corrugated steel and bronze hose is available in standard sizes from 3/16" through 14" I.D. for burst pressures to 12,000 psi, temperatures to 1000° F. Stainless steel types also available.

CMH convoluted hose is available for lower pressure applications in a variety of types including square locked, ball bearing and fully interlocked . . . in steel, bronze and other alloys. Sizes up to 12" I.D.

CMH FLEXIBLE METAL HOSE

Isolation of vibration is easy and economical when you use CMH Metal Hose to connect rigid piping to machinery. Metal hose assemblies are quickly installed, just like a length of pipe. The flexibility of the unit effectively absorbs vibration while the all-metal construction assures long, dependable service. If you have a vibration problem in your piping it will pay you to consider CMH Flexible Metal Hose. Your Flexonics distributor can give you full information. Look for his name in your classified telephone directory.

CHICAGO METAL HOSE Division

Flexonics *Corporation* 1335 South Third Avenue, Maywood, Illinois

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Flexon identifies CMH products that have served industry for over 50 years.

CMH

Flexible metal hose

Expansion joints.

Aircraft components

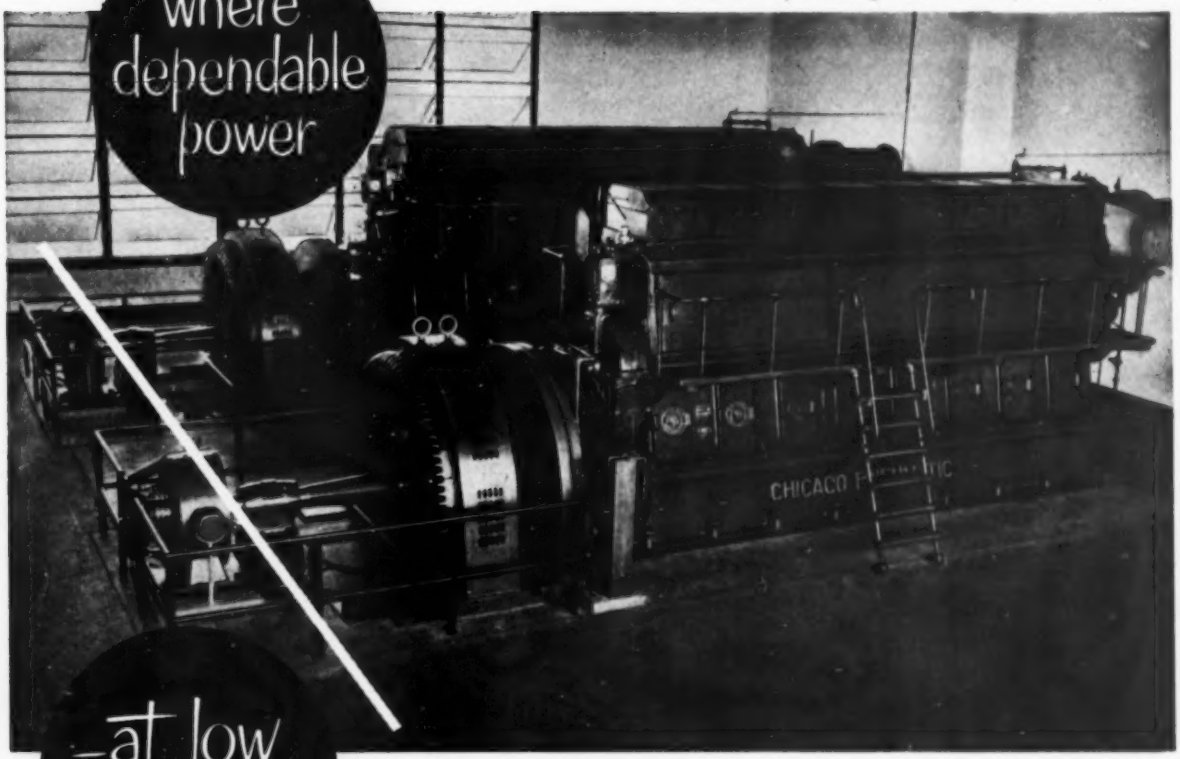
Metallic bellows

where dependable power

-at low cost-

is a "MUST"

Two CP 1500 hp Diesel Engines in a western public utility station.



CP ENGINES, for straight Diesel, Dual Fuel, or Gas operation, have earned an enviable reputation for providing thoroughly dependable power at low cost. They are widely used in public utility stations, municipal power plants, institutions, petroleum pipeline stations, and in many kinds of industrial plants.

They are particularly suitable for voltage booster stations at the end of long transmission lines; for emergency hook-ups during power line repairs and replacements; for local generating plants in isolated areas; as well as for furnishing power in central stations.

Available in units up to 1750 hp., the CP line includes both normally aspirated engines and supercharged engines incorporating the Elliott Turbocharger.

CHICAGO PNEUMATIC TOOL COMPANY

General Offices: 8 East 44th Street, New York 17, N. Y.

PNEUMATIC TOOLS • AIR COMPRESSORS • ELECTRIC TOOLS • DIESEL ENGINES
ROCK DRILLS • HYDRAULIC TOOLS • VACUUM PUMPS • AVIATION ACCESSORIES

RESEARCH KEEPS **B.F.Goodrich** FIRST IN RUBBER

Where failures meant shutdowns they changed to grommet belts

B. F. Goodrich grommet V belts last 20 to 50% longer

Crushing rock puts terrific shock loads on the V belts that drive the crusher. When the drive stops because of premature belt failure, the whole operation shuts down, deliveries are delayed. The stone company wanted reliability—and got it—when a set of B. F. Goodrich grommet V belts was installed. In spite of the shaking, jolting action, the grommet V belts on this crusher have already given two years of trouble-free service, and are still in excellent condition. Here's why B. F. Goodrich grommet V belts outlast and outperform ordinary belts.

No cord ends

A grommet is endless, made by winding heavy cord on itself to form an endless loop. It has no overlapping ends. Because most of the failures in ordinary V belts occur in the region where cords overlap, the endless cord section in a grommet V belt eliminates such failures.

Concentrated cord strength

All of the cord material in a B. F. Goodrich grommet belt is *concentrated* in twin grommets, positioned close to the driving faces of the pulley. There are no layers of cords to rub against one another and generate heat; cord and adhesion failures are reduced. And grommet V belts stretch less—only ⅓ as much, on an average, as ordinary V belts.

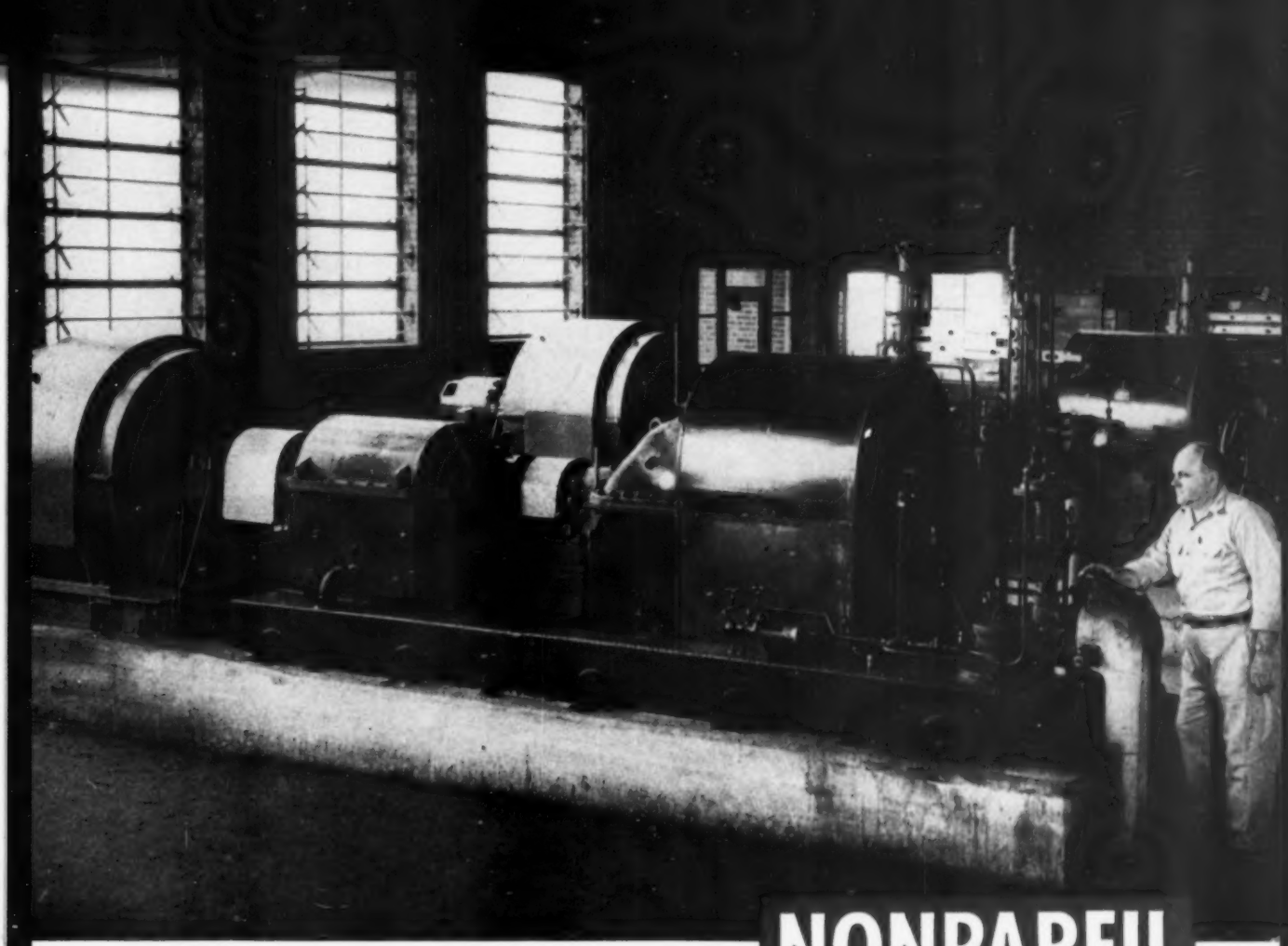
Better grip, less slip

Grommet V belts have more rubber in relation to belt size. Without any stiff overlap, they're more flexible, grip pulleys better. Size for size, grommet belts give ⅓ more gripping power, pull heavier loads with a higher safety factor. Because there is less slip, there is also less surface wear.

They cost no more

Grommet V belts cut costs because they last longer, increase production because machines keep running with fewer interruptions, reduce maintenance costs because they need less attention, yet they cost not one cent more. Available in C, D and E sections. But remember, only B. F. Goodrich makes the grommet V belt (U. S. Patent No. 2,233,294), so to get all these savings, call in your local BFG distributor the next time you need V belts, or write *The B. F. Goodrich Company, Industrial & General Products Division, Akron, Ohio.* (Available in Canada)

Grommet V-Belts BY
B.F.Goodrich
RUBBER FOR INDUSTRY



Turbine oil systems stay clean with...

NONPAREIL
TRADE MARK
Turbine Oil

• When the two turbines shown above were installed in a large Milwaukee tannery, they were filled with NONPAREIL Turbine Oil. NONPAREIL lubricates each turbine and its reduction gear unit from one oil reservoir.

During nearly two years' operation, the original fills of NONPAREIL were not removed from the turbines either to clean the oil systems or to treat the oil. Neutralization numbers stayed below 0.04 mg. KOH/gm. Recently, plant officials and a representative of the turbine manufacturer made a thorough inspection of the turbines' lubricating systems. They found gears and bearings in excellent condition. They found no appreciable deposits either in the turbine oil or in the lubricating systems. The turbine manufacturer's representative expressed approval of the job being done by NONPAREIL Turbine Oil.

Through the use of NONPAREIL, officials of this Milwaukee tannery are assured of clean, trouble-free lubrication for the *life* of their turbines. This assurance is based on the written guarantee, given with each fill of NONPAREIL, that this outstanding lubricant will last for the *life* of the turbine it lubricates and that it will maintain a neutralization number below 0.15 mg. KOH/gm.

The Standard Oil lubrication specialist in your section of the Midwest will be glad to tell you about NONPAREIL's written guarantee. He will show you NONPAREIL operating records that cover up to 25 years' service in a single turbine. You can contact this lubrication specialist by phoning your local Standard Oil office. Or write, Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY

STANDARD

(Indiana)

Complete Seating Contact!

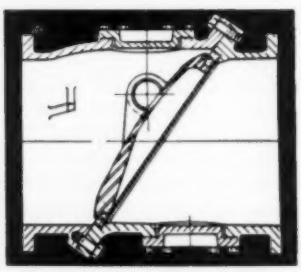
You know you've got it with . . .

CHAPMAN

Exclusive TILTING DISC *Check Valve*

Nothing can "unseat" the disc-ring of this valve from its *drop-tight* contact with the body-ring . . . because clearance at the hinge-pins means that this contact is *complete.* There is no sliding action, consequently no wear, no leakage. And the pivoted disc is cushioned to an easy, silent closing . . . without slam . . . in installations that don't have unusual piping arrangements.

What's more, hydraulic laboratory tests at a top engineering school prove that the specially designed disc and streamlined valve-body reduce head loss as much as 80% under conventional swing-type check valves. See the graphs of these tests . . . and illustrations of the unique construction features of Chapman Tilting Disc Check Valves . . . in Catalog No. 30 (yours for the asking). *Write.*

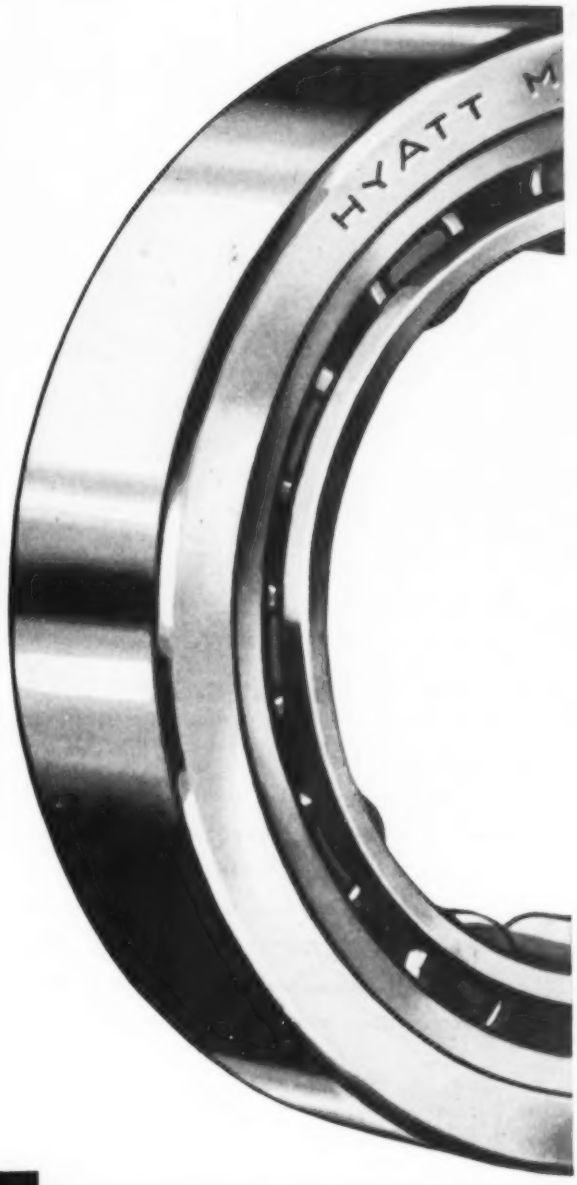


Cross-section of the Chapman Tilting-Disc Check Valve. A feature of the design is that the disc seat lifts away from the body seat when opening, and drops into contact when closing, with no sliding or wearing of the seats.

THE CHAPMAN VALVE MFG. CO.

INDIAN ORCHARD, MASSACHUSETTS

10 designs for heavy duty



Ten different Hyatt Hy-Load designs, each in a variety of widths and sizes, assure you the right bearing for every radial need.
Four Hy-Load designs have separable inner races, two have separable outer races and four are non-separable. All are high-capacity, cylindrical roller bearings for the heaviest radial loads and light or intermittent thrust loads.
All separable parts are freely interchangeable within the same size. This permits non-selective fitting after pre-assembling the two bearing parts in separable machine elements.
Whatever your radial load problem, Hyatt Hy-Loads or some of the other types of Hyatt bearings can provide the answer. Because Hyatt offers industry's most complete line of straight radial roller bearings. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

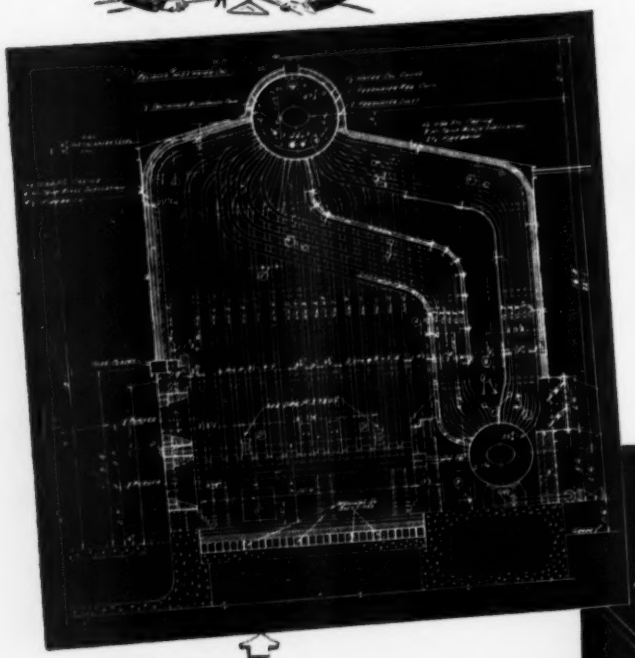
HYATT ROLLER BEARINGS

Industry Approved

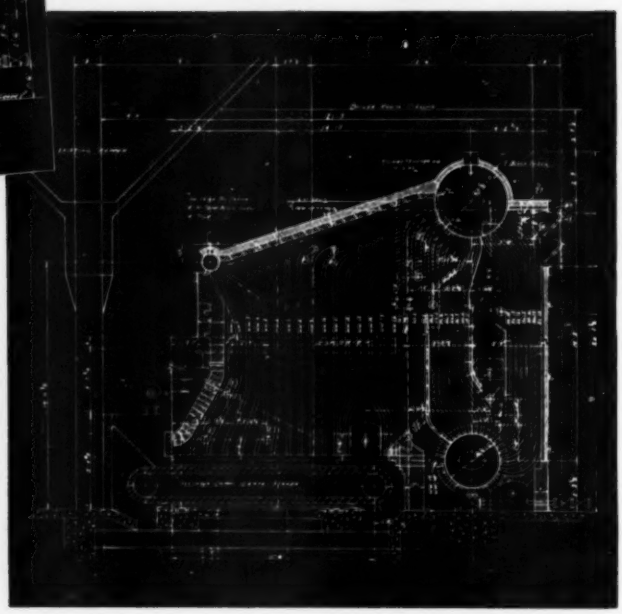
Two-Drum

STEAM GENERATORS

by Vogt



CLASS VF
A 22,000 pounds steam per hour unit installed at Indiana Farm Bureau Refinery, Mt. Vernon, Ind.



CLASS VS
The Seelbach Hotel, Louisville, Ky. is served by this 30,000 pounds steam per hour boiler.

A wide variety of industrial plants and other users of steam for power, processing, or heating have found these efficient Vogt Two-Drum Type Boilers to be the answer to their diverse steam generating requirements.

Class VF units provide maximum capacity in limited floor space and head room, while Class VS is best adapted to installations not having such restrictions. Each has a large furnace volume and a high ratio of radiant heating surface. The furnace design assures proper combustion of fuels fired in suspension or with various type of stokers.

A bulletin with general information and showing typical installations is available on request.

Typical Users...

FOOD PROCESSING PLANTS

DISTILLERIES • HOTELS

HOSPITALS • CHEMICAL PLANTS

PETROLEUM REFINERIES

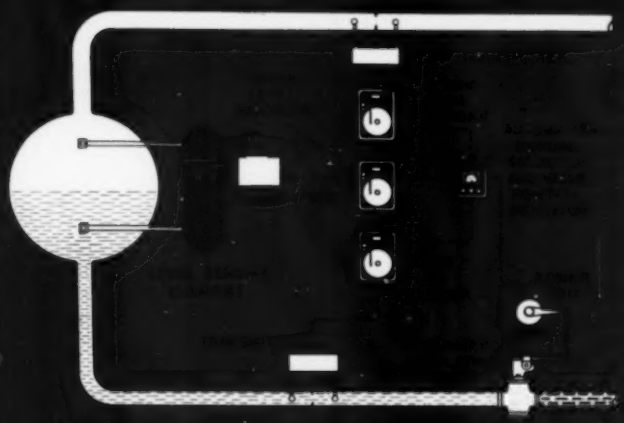
HENRY VOGT MACHINE CO., Louisville 10, Kentucky

BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS, CHARLESTON, W. VA.

a new electronic feedwater control!

electronic null balance remote operation

control operative even on cold boilers



pressures up to 2500 lbs.

positive valve drive —cannot freeze

THREE ELEMENT CONTROL SYSTEM

mercury-less measuring and transmission for flow and level

1, 2, or 3 element control available

HAYS Electronic Feedwater Control

One, two, or three element control systems for all boilers, large and small, even under the most severe operating conditions.

Existing instruments can be used — steam flow meters, water flow and level meters.

Buoyant float *level measuring unit* with torsion tube — no seals or packing. Direct measure of level. No blow-down necessary for start up.

Bellows type *flow measuring unit* — no mercury. Overpressure protection — convenient range change.

Electronic *controller* for speed of transmission and accuracy of control. Independent adjustments for effects of steam flow, water flow and water level.

Fast, electronic rebalancing *recorder*. Continuous integration.

Write today for full information on the Hays Electronic Feedwater Control System Bulletin 52-1073-221.

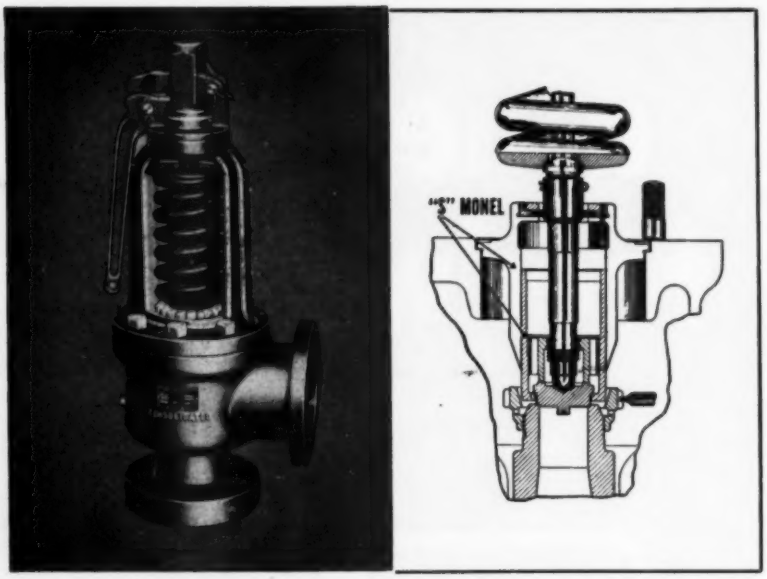
Automatic Combustion Control
Boiler Panels • Hays-Penn Flowmeters
Veriflow Meters and Veritrol
Gas Analyzers • Draft Gages
Combustion Test Sets • CO_2 Recorders
Electronic Oxygen Recorders
Electronic Flowmeters
Electronic Feed Water Controls
Miniature Remote Indicators

THE hays CORPORATION

MICHIGAN CITY 2 INDIANA

'S' Monel...

FOR RESISTANCE TO GALLING AND EXTRA HARDNESS AT HIGH TEMPERATURES



"Consolidated" Safety Valves like this have guide sections of extra hard "S" Monel. Manning, Maxwell & Moore, Inc., standardized on "S" Monel after extensive tests under simulated operating conditions. All proved "S" Monel an outstanding metal for resistance to galling and seizing.

Are you looking for a casting alloy for parts subject to high stress and severe friction under corrosive conditions?

Then take a look at "S" Monel.

"S" Monel is one of the hardest and strongest of the non-ferrous casting alloys.

Its coefficient of expansion closely matches that of carbon steel to give excellent service where clearances are small and operating temperatures high.

"S" Monel retains its hardness at elevated temperatures. It resists galling under severe conditions, even where lubrication is poor.

And because of its hardness it is highly resistant to abrasion and erosion.

It can be machined as cast. For extensive machining the casting may first be annealed and later age-hardened to develop its maximum hardness. It is not recommended for welding.

You'll find "S" Monel used as the guiding parts in safety valves, in valve discs and seats, impellers, wearing rings, bushings, sleeves, ejector nozzles and pump liners.

"S" Monel has helped many manufacturers in solving their metal selection problems.

Take for instance the problem of Manning, Maxwell & Moore, Inc.

They wanted a valve trim material that would hold up in the "Consolidated" Safety Valves.

The material had to be able to resist galling and seizing at high temperatures.

Many alloys were tested in combination with themselves and with other alloys, and "S" Monel consistently showed superior anti-galling properties. Now "S" Monel has been made the standard for the guiding sections of their high temperature "Consolidated" Safety Valves.

For more information on "S" Monel, write to Inco's Technical Service Section. They'll be glad to supply you with information and assistance.

Mechanical Properties of "S" Monel*

(Annealed and Age-hardened)

Yield Point	80-115,000 psi
Tensile Strength	120-145,000 psi
Elongation in 2-in.	4-1%
Hardness (Brinell)	300-375
Coefficient of Thermal Expansion (32°-212°F.) in./in/°F.	.0000068

Hardness of "S" Monel at Elevated Temperatures*

(As-cast condition)

Temperature, °F.	Brinell Hardness
Room	321
700	321
800	311
900	311
1000	321
1050	335
1100	293

*Average properties—not to be used for specification.

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY • NIMONICS®

TERRY

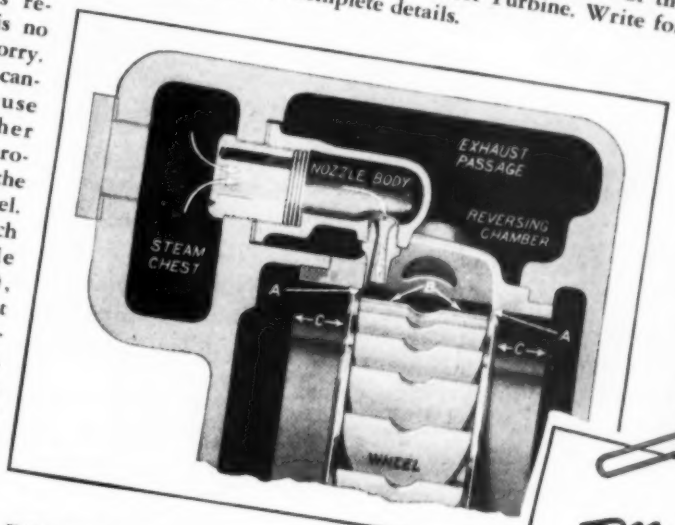
LARGE CLEARANCES take the "worry" out of Turbine Operation

In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.



THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

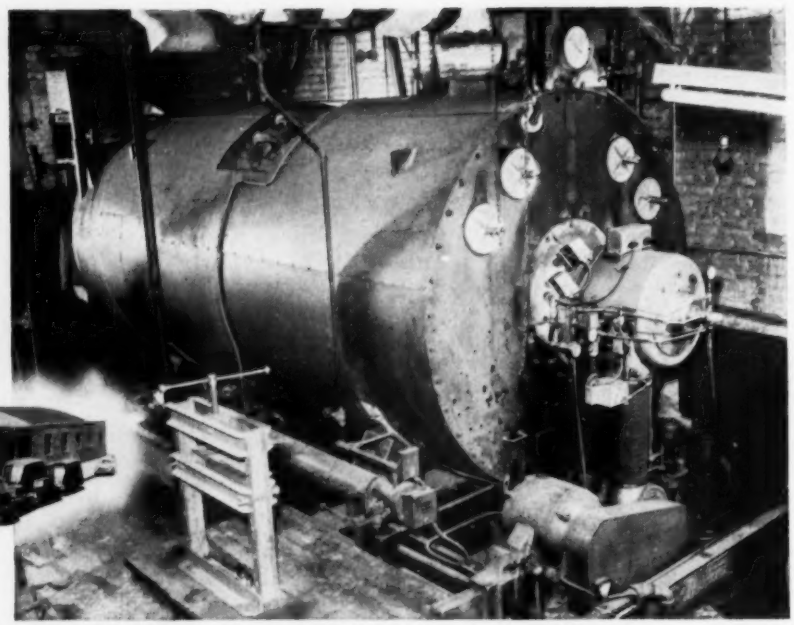
Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.

Powermaster®

CUTS STEAM COSTS ⅓

at large New York cleaning plant

I. WOHL, INC., Long Island City, N. Y., is one of the largest wholesale dry cleaning firms in the metropolitan New York area.



The 300 h.p. Orr & Sembower POWERMASTER boiler generates dry steam at 100 psi for drying, pressing, spotting, heating wash water, and for winter comfort heating. No. 6 Bunker C residual fuel oil is burned automatically.

● Here's what Henry Falkenberry, Chief Engineer at Wohl, has to say:

"The operating personnel are enthusiastic about the Orr & Sembower boiler. It is well liked by everyone principally because of its fully automatic operation and minimum attention that is required. The automatic operating controls keep the steam pressure constant even with widely varying steam demands.

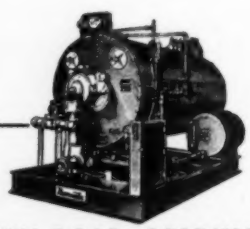
"Freedom from maintenance is another outstanding advantage to us. Cleaning is done once every six months and we feel this could be cut to once a year. The old boiler had to be thoroughly cleaned every week. Furthermore, there has been no work interruption or trouble of any kind encountered over the past two full years of 24-hour-a-day operation."

Before deciding on a boiler for your plant, be sure to get the facts on the newest POWERMASTER with VORIFLOW combustion. Write for this catalog that gives you the entire story of the *Powermaster* packaged automatic boiler. Just drop us a line and we'll put one in the mail for you.

Powermaster®

PACKAGED AUTOMATIC BOILERS

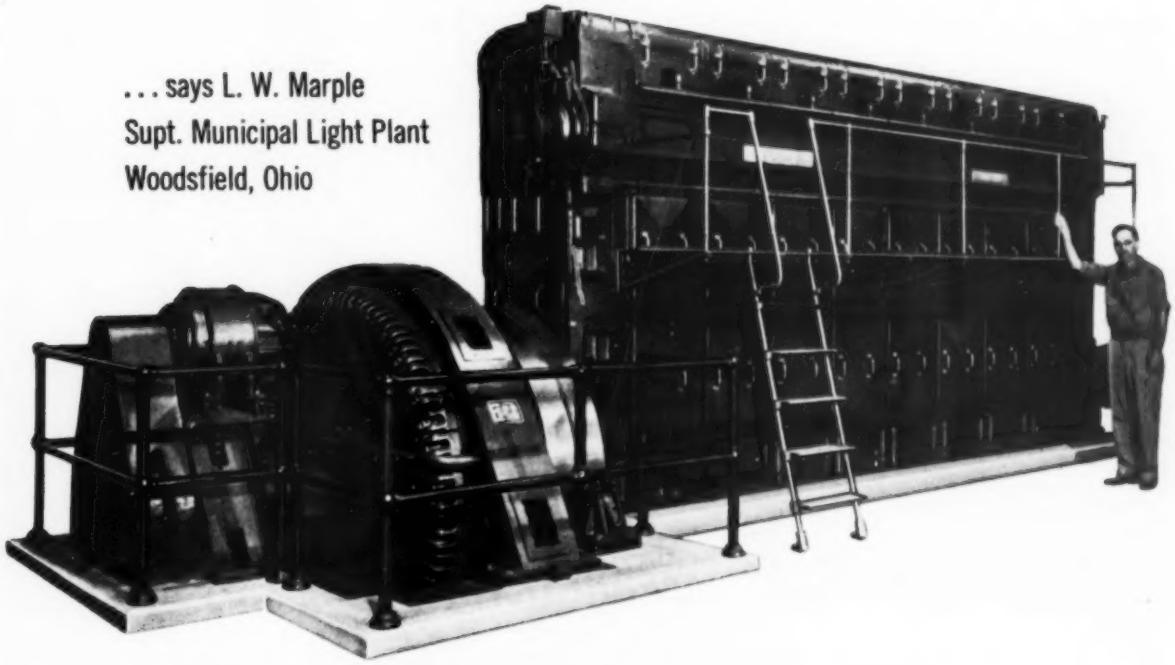
In sizes to 500 h.p.; pressures to 250 psi.



ORR & SEMBOWER, INC. • *Established 1885* • 950 MORGANTOWN ROAD, READING, PA.

"No More Sticking Rings..."

... says L. W. Marple
Supt. Municipal Light Plant
Woodsfield, Ohio



● "Because of the lubricating oil we were previously using," says Mr. Marple, "sticking rings and carbon build-up were persistent problems on our three Fairbanks-Morse Model 32-E diesels.

"Three years ago, at the recommendation of one of your lubrication engineers, we switched to Sinclair GASCON® Oil D — HD.

"GASCON D — HD has cleared up our troubles... no more sticking or broken rings... no more carbon build-up, even though our load factor has increased. The result is a considerable savings in maintenance costs.

"We are also getting outstanding results with GASCON in our new 875 H.P. National Superior Dual Fuel Engine."

Perhaps a Sinclair Lubrication Engineer can solve *your* lubrication problems. Call your local Sinclair Representative or write to Sinclair Refining Company, 600 Fifth Avenue, New York 20, N. Y.

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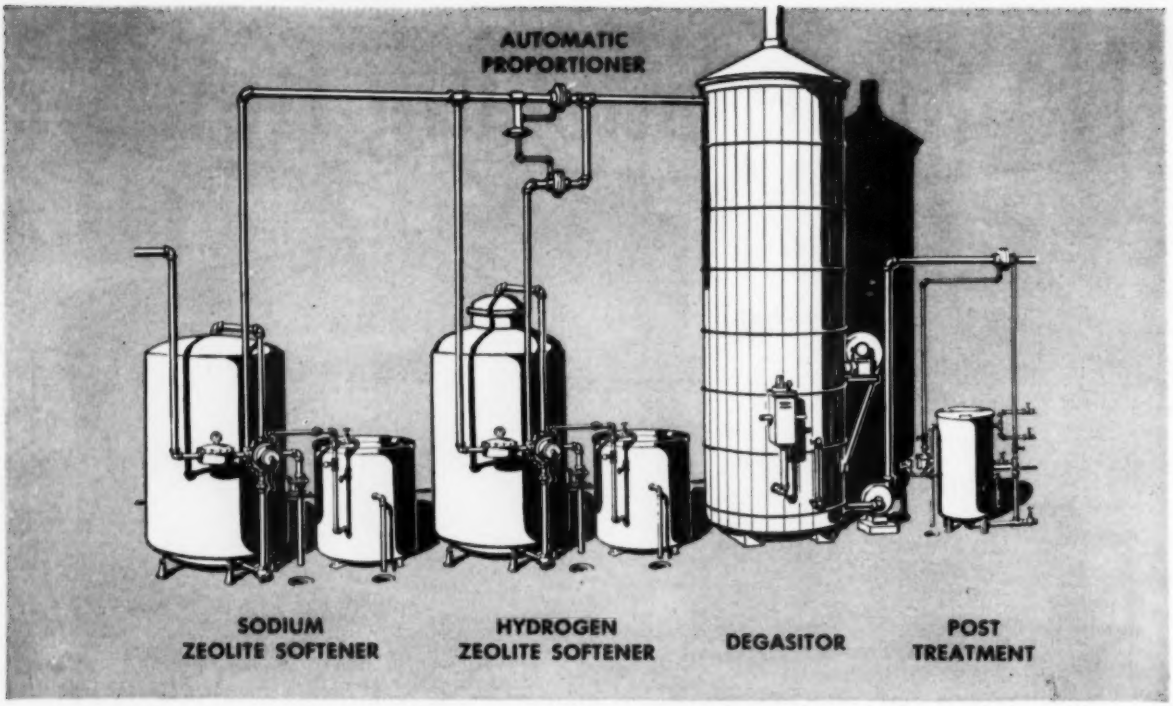

This Elgin "Split Stream DeAlkalizing" System

Eliminates Boiler Scale, Corrosion, and Excess Alkalinity At Taylor Oil and Gas Company

Taylor Oil and Gas Company, Corpus Christi, Texas is one more in a long list of well known firms that have selected Elgin Water Conditioning for their exacting requirements.

With the system graphically illustrated above, blended effluents from sodium and hydrogen zeolite water softeners, followed by degasification, give zero soft water in which total solids and alkalinity is reduced and CO_2 is removed. Boiler water alkalinity is kept in proper proportion to total dissolved solids. The dissolved solids have been reduced 34.5%. (On waters of higher alkalinity, a greater reduction is obtained.) Blowdown is reduced approximately 35%. Think how much this alone saves. Costly destruction resulting from return line corrosion is prevented. And as an extra dividend, post-treatment costs are cut to a minimum.

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This is but one of our many water conditioning systems. We make all types, ranging from the outstanding "Double-Check" zeolite water softener which gives up to 44% more soft water, to the Ultra-DeIonizer which produces water of the highest known chemical purity.

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WATER CONSTITUENTS	RAW WATER Gr/Gal	TREATED WATER Gr/Gal
Carbonate (Alkalinity)	4.95	0.73
Sulfate	3.15	3.15
Chloride	4.08	4.08
Calcium	3.04	0.03
Magnesium	0.42	0.02
Sodium	3.66	4.68
Total Dissolved Solids	19.30	12.69
Reduction in Dissolved Solids		**34.5%**

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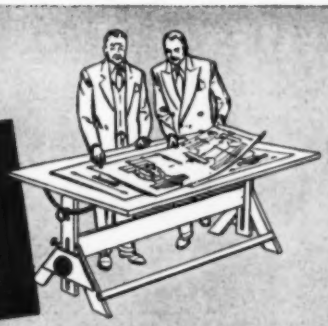

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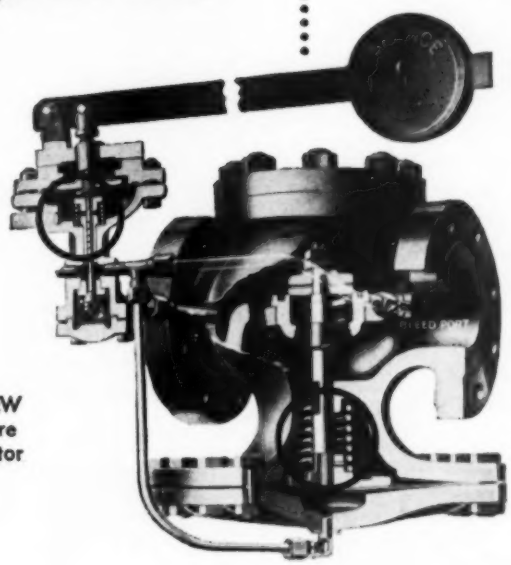
Spence makes a wide line of automatic regulating valves: Pressure, Temperature, Differential Pressure, Back Pressure, Pump Governor and many other types. Write for bulletin 100 giving full details.



Type EW Pressure Regulator

A few other design features:

SECO METAL SEATS AND DISCS—Durable SECO Metal resists wiredrawing. More than twenty years of experience in thousands of installations has failed to produce a single case where SECO Metal has been cut by steam.

LARGE BALANCED METAL DIAPHRAGM located in a cooled zone with a condensate seal above and below it, never has to be replaced under normal conditions.

PACKLESS CONSTRUCTION—All Spence main valves and most pilots are built without stuffing boxes. This minimizes friction . . . reduces valve stem wear and eliminates time-consuming maintenance.

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SPENCE ENGINEERING COMPANY, INC.

WALDEN, NEW YORK

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Philadelphia

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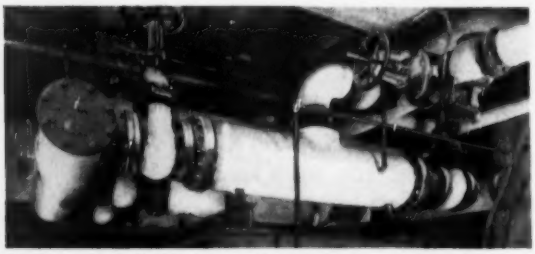
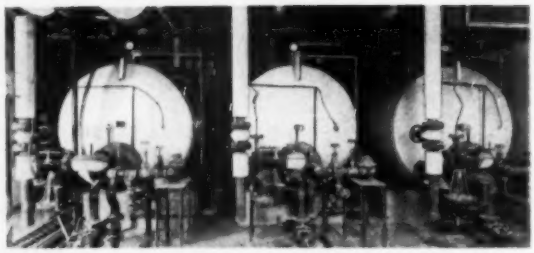
where p-k equipment is at home.....at work

This new, modern apartment house is well equipped to supply its 482 tenant-families with adequate heat and clean, hot water—and the same **p-k** equipment keeps pavement areas free of snow in winter time. Like many other modern apartment owners, **p-k** equipment was chosen by the owners of the Rittenhouse-Claridge for efficient, dependable, economical operation.

Full information and engineering help is yours for the asking. Write today.



Three Type O **p-k** single pass Hot Water Converters are in use at the new, modern Rittenhouse-Claridge. Each heats 785-gpm of water from 160°F to 180°F with steam at 25# psig pressure.



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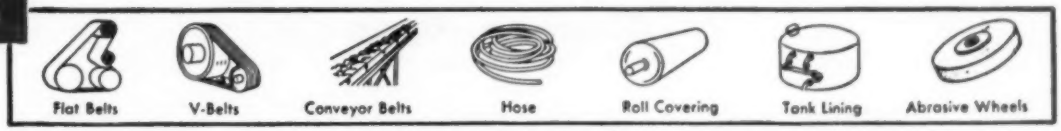

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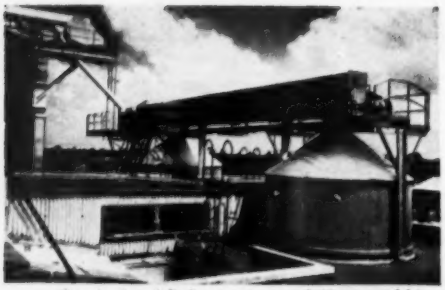
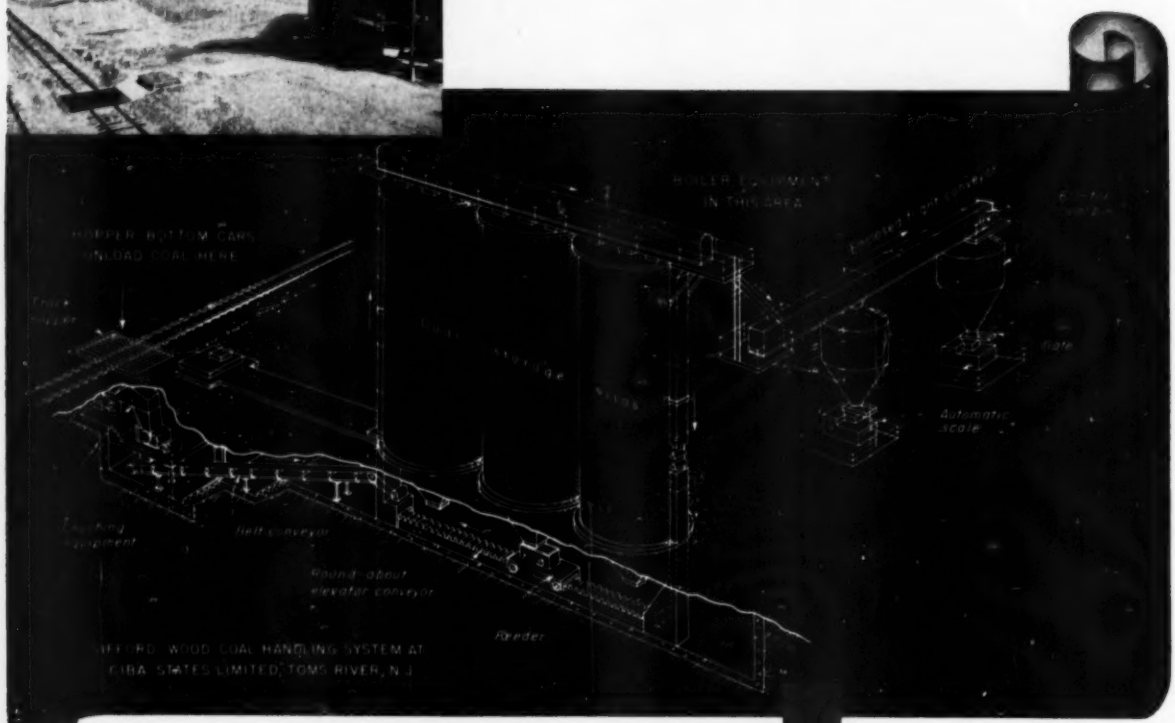


Enclosed flight conveyor and 60-ton coal bin.

Under-track hopper and coal storage silos.

ANOTHER G-W AUTOMATIC COAL HANDLING SYSTEM...

this time for Ciba States Ltd.



G-W COAL HANDLING SYSTEM AT CIBA STATES LIMITED, TOMS RIVER, N. J.

Now nearing completion at Toms River, N. J., is the world's most modern vat-color producing plant—and helping insure maximum power development with top economy will be the most efficient coal handling system, by Gifford-Wood. The system was designed and built by G-W engineers for Ciba States Limited, and includes unloading, storage, and feeding facilities.

For more than 140 years, G-W has met and solved materials-handling problems. This experience, coupled with planned application of the most modern equipment, is at your disposal. This project is only one example of complete design, construction, and erection under one responsibility

For details on this, or other Gifford-Wood coal handling installations, please write for Bulletin No. 300.

As diagrammed, coal passes from hopper cars through crushers, and then by means of belt and bucket conveyors, to silo storage. Transfer of coal from storage silos is by gravity feed into a movable car from which the bucket elevator lifts it, by-passing the storage silos, to an enclosed flight conveyor discharging into bins, which feed through coal scales to pulverizers.

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Freeze-ups of outdoor steam traps in winter weather often cause production delays. Don't take that chance . . . especially when it's so easy to install Yarways, the steam traps that *won't freeze up.*

They won't freeze because condensate does not accumulate. The only moving part—a little valve—is continually testing for condensate, discharging it as soon as it forms. There's never anything to freeze.

Other reasons why over 750,000 Yarway Impulse Steam Traps have been sold—they get equipment hotter, sooner; light weight; small size; easy to install and maintain; good for all pressures; made of stainless steel.

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the steam trap designed with more production in mind

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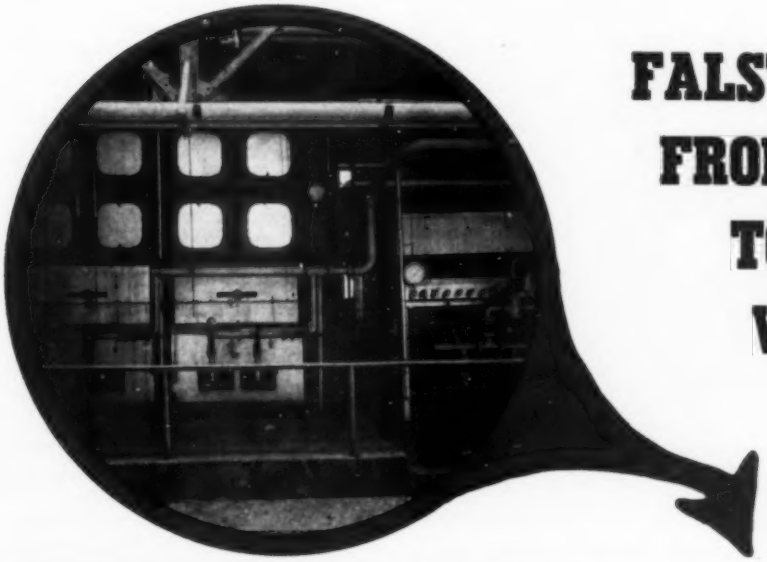
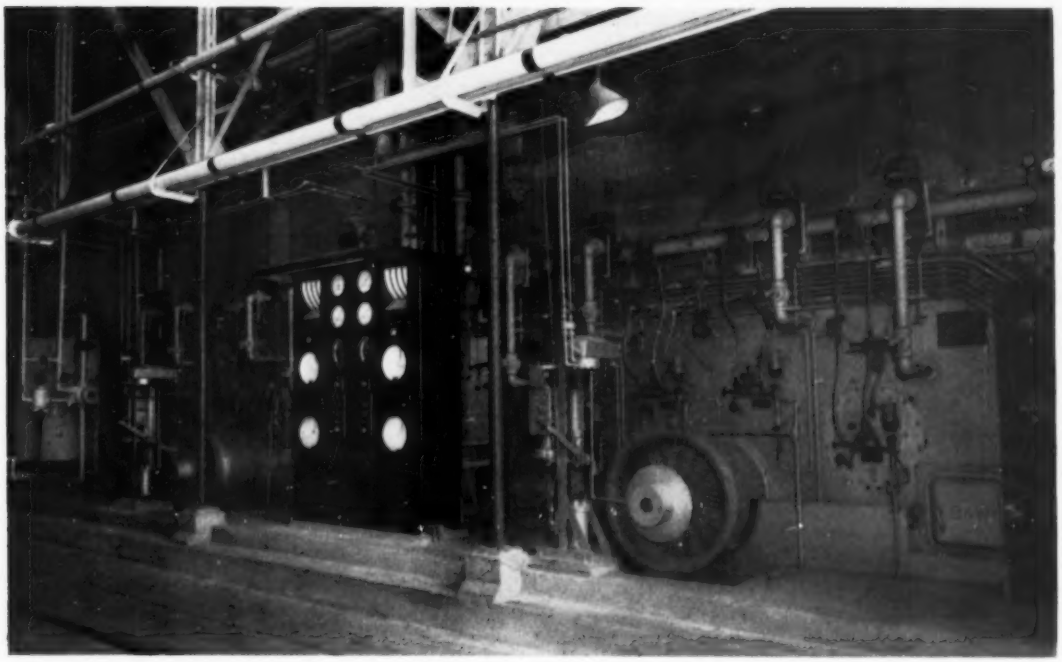


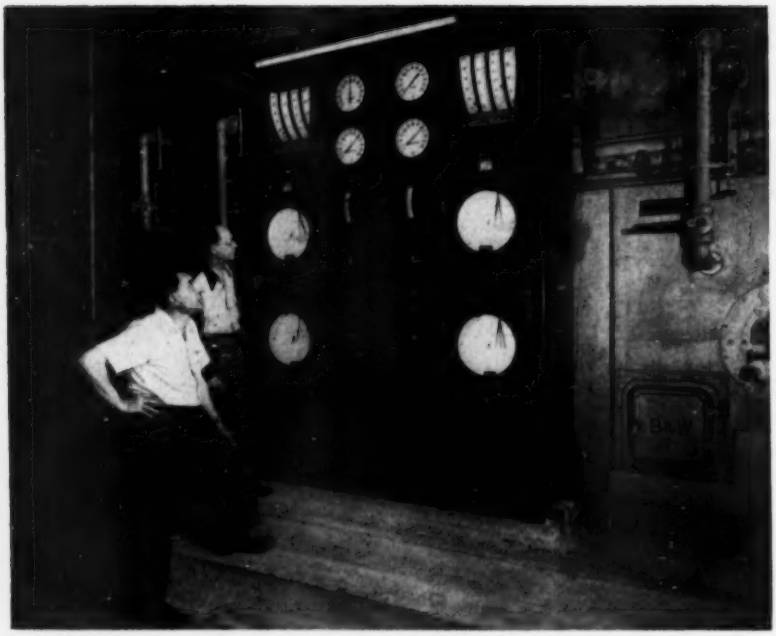
FALSTAFF GOES FROM OLD TO NEW WITHOUT A SHUTDOWN



Circled view shows the old boilers, which were dismantled to make way for the new, above. One old boiler was removed and replaced, while the other two remained on line. The new boiler was in place and operated for two weeks before the other two units were removed. Units are fired with gas but can be changed over to oil fuel at a moments notice. Each boiler has a capacity of 50,000 pound of steam per hour, operating at 200 psi

Falstaff Brewing Corp., during a recent remodeling program, not only installed new boiler equipment without a shutdown, but added ammonia refrigeration units as well without loss of time. Time schedules and material deliveries were geared to perfection

CHARLES H. BERGMANN, ***Superintendent of Engineering***
Falstaff Brewing Corporation



Elaborate control and recording instrument panel, located between the two boilers, indicates the plant operation at a glance. All control and recording equipment is of the latest design and is completely automatic

DURING the recent expansion and modernization program of the Falstaff Brewing Corporation's New Orleans plant, it was decided to install a complete new boiler plant to furnish steam and power for plant operations. But, due to space limitations, it was necessary to install the new equipment in the same area occupied by the old, and this imposed some interesting problems.

How well these problems were solved is attested to by the fact that there was no plant shutdown due to the boiler installation program during its entire two-year span.

The brewery's plan called for installation of two boilers, rated at 50,000 lb per hr with a design pressure of 200 psi, combustion controls, feed water regulators, combustion safeguards, and combination oil and gas burners.

Additional new boiler plant equipment consisted of a deaerating boiler feed water heater, rated at 60,000 lb per hr, turbine-driven centrifugal boiler feed water pump, and a motor driven boiler feed water pump.

Existing water softeners and boiler feed water treating system were reconnected to the new installation, and the existing fuel oil pumps and heaters were re-located. This new equipment was installed in the area occupied by the three old boilers, the old boiler feed water heater, and the steam driven boiler feed water pumps.

The new deaerating boiler feed water heater was installed in the same location as the old unit, and to accomplish this, it was decided to build a temporary surge tank, which was erected at the rear of one of the old boilers. This was made from an old discarded air tank, 42 in. in dia and 5 ft long. After cutting the head out, the engineering department installed a 2 in. city water line from the water softeners to the tank, using a float valve to regulate the water level in the surge tank. All condensate return lines were also connected to this tank. The two old boiler feed water pumps were then connected, and boiler feed water was pumped from the temporary surge tank to the old boilers.

Timing, which was to have an important part in keeping the plant running with no shutdowns, now came into play. Connections for this temporary surge tank were completed to allow final connections to be made over a weekend, when the plant was not operating, and thus no production was lost.

Old boiler feed water heaters and pump connections were then removed and the new boiler feed water heater and boiler feed water pumps installed with inter-connecting water and steam piping.

Next step in the modernization program was the removal of one old boiler to make room for one of the new boilers. As soon as this boiler was removed, excavation and foundation work for the new boiler was completed, and one of the new boilers was erected with the necessary steam header piping and breeching connections, feed water piping, and other connections. Again, following a strict time schedule, final connections were made over a weekend when the plant was idle.

During this entire time, the two remaining boilers were operating without a standby, and it is to the credit of the operating engineer and his personnel that no mechanical failures resulted at any time during this period.

After the new boiler had been in operation about two weeks, and the operating personnel become thoroughly familiar with it, the two old boilers were cut out and dismantled. Again, for a period of five months the plant was without standby power, but there was no shutdown or loss of power.

Each new boiler is capable of 50,000 lb of steam per hr continuous rating, and each is equipped with forced draft steam atomizing combination burners. These are so designed that gas is the principal fuel, but oil may also be used as an auxiliary fuel. The combustion controls system is complete in every respect.

REFRIGERATION SYSTEM

Included in the modernization plans for the plant as a whole was a substantial increase in the brewing capacity. This, of course, necessitated an increase in the plant's refrigeration system, which was increased by 425 to its present capacity of 1000 ton a day.

New equipment was installed to replace old equipment. To increase the capacity an 11 by 10 in. four-cylinder vertical ammonia compressor directly connected to a 300 hp synchronous motor was installed.

Also installed were two 11½ by 10½ in. twin-cylinder ammonia compressors operating at 360 rpm. These compressors are driven by steam turbines, operating at 3240 rpm, 150 psi steam throttle and 5 psi exhaust pressure. Gear reduction units were used to reduce the compressor speed.

Two new 200 ton capacity shell and tube ammonia condensers were added to service the refrigeration system, and a new induced draft cooling tower extension of 1500 gpm capacity was added to the existing 3000 gpm capacity induced draft tower. This cooling tower is constructed of redwood, with a redwood cooling basin. A new liquid ammonia receiver, 36 in. in dia and 14 ft long, was installed and connected to the existing ammonia receiver.

Exhaust steam from the two steam turbines is used to heat water used in

the brewing process. This exhaust steam is also used for heating boiler feed water, and, during the winter months, for the plant space-heating requirements. Through this use, a good heat balance is secured throughout the entire plant, with efficient operation, since no live steam is needed to heat the brewing water.

In addition to this equipment carbon-dioxide compressors, well water pump with a rated flow of 1000 gpm, city water booster pumps, three 333 kva power transformers and two 50 kva lighting transformers, switchboards, and many inter-connecting lines, power, steam, ammonia, and process were also installed.

PLANT INSTRUMENTATION

Accurate control of temperatures throughout the brewing process is essential if the various brews are to be uniform in quality, taste and character. In the New Orleans plant of Falstaff Brewing Corporation, these controls are accomplished by complete instrumentation throughout the plant.

Boilers are efficiently operated through a combustion control panel, which gives the complete operation of the boilers at a glance. In addition, a minute-by-minute record of the operations is made to give the chief engineer a permanent record of operating efficiency.

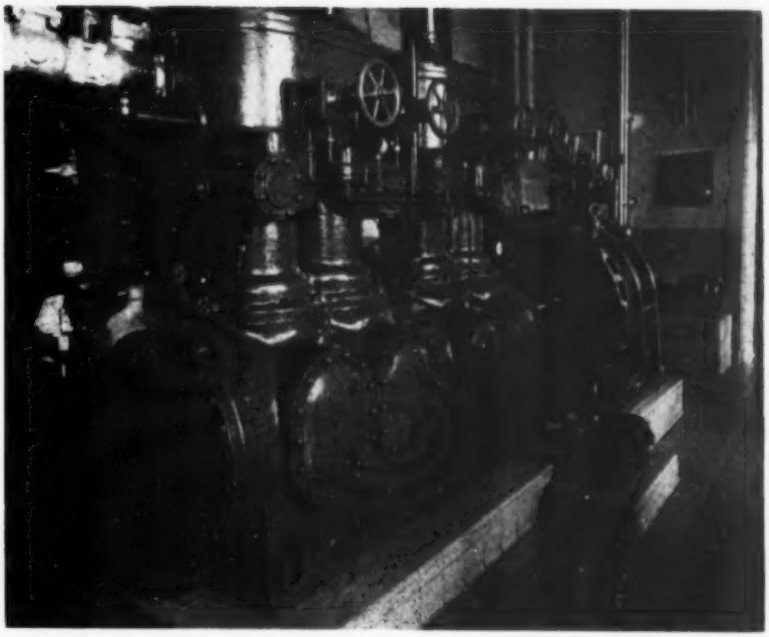
This control panel includes the following instruments and controls for each boiler; four unit draft indicators, steam pressure gage, feed water pressure gage, boiler level indicator, feed water flow and temperature recorder, steam flow, air flow, and steam pressure recorders, boiler rating valve, boiler manual control station, CO_2 and exit gas temperature recorder, and push button-operated forced draft fan.

In addition to the combustion control panel, each boiler has complete combustion safeguards, which are mounted on a separate panel for each boiler.

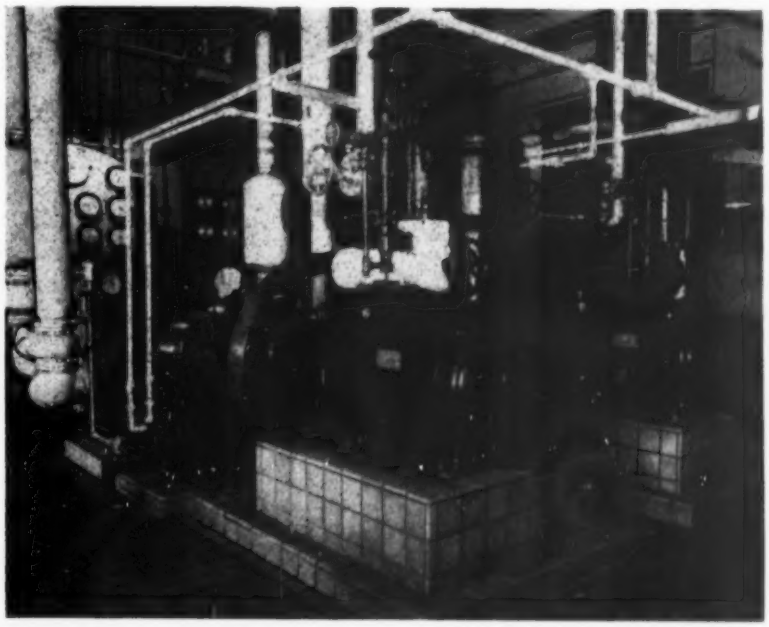
Steam to each department is measured through recording steam flow meters, while electric power is also metered to each department, so that an accurate check may be kept.

In the refrigeration plant, the ammonia suction and discharge pressures are recorded constantly through the use of recorders, which give the chief engineer and his staff a 24 hr record of operating conditions in the system.

All phases of the brewing process are constantly recorded and controlled automatically. All the temperature recorders, steam gages, temperature indicating gages, and equipment controls are mounted on stainless steel panels conveniently located for efficient operation and easily kept clean and sanitary.

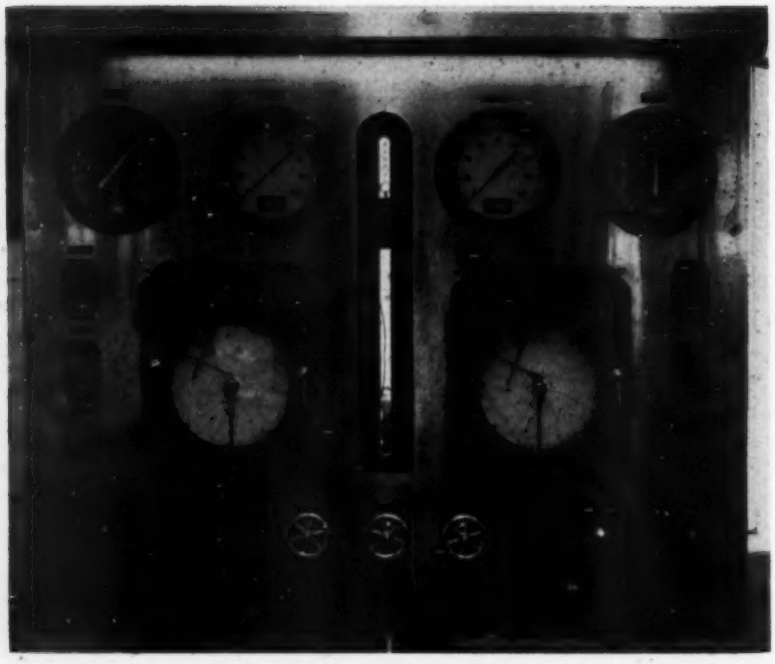


This 11 by 10 four cylinder vertical ammonia compressor is direct connected to a 300 hp synchronous motor. The unit furnishes just a part of the 1000 ton of refrigeration required daily for the brewing process and storage rooms

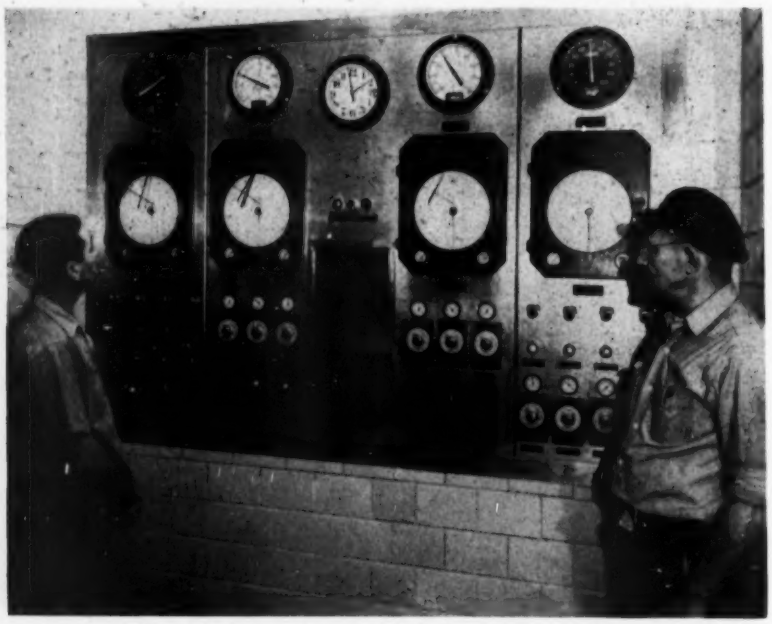


To obtain good steam balance these two 11½ by 10½ vertical twin cylinder ammonia compressors are steam turbine driven. The compessor operates at 360 rpm through gear reduction unit, while the turbines turn at 3240 rpm

Tub and brew kettle temperatures are recorded, and a complete control system to handle the flow of water used in the brewing process, called *sparge water*, has been installed. In the *sparge water* tanks, located on the fourth and fifth floors of the new building addition, accurate temperatures must be maintained, so that each brew is exactly like its predecessor. This water is heated by exhaust steam from the turbines. Recorder-con-



This panel gives the brewmaster complete control of both the brew kettle and lauter tub in the processing of one brewing line. Recording instruments maintain a complete and permanent record of the entire brewing process



Each system in the brewing process has its own instrumentation panel. Here is the panel for the controls and recorders for the wort cooler operation

trollers and an air-operated steam valve to each hot water tank control the amounts of steam needed to keep the temperature constant.

The brewmaster or an assistant controls the flow of water to and from the *sparge water* tanks located on the fourth floor from a control panel located on the second floor that is at the heart of the brewing operation.

This stainless steel control panel indicates the level and temperature of the *sparge water* constantly, while inlet and outlet valves are operated by remote control from this location.

In addition, each mash tank and cereal cooker used in the brewing process is equipped with a time schedule recording controller.

Stainless steel wort coolers, which lower the temperature of the hot wort from 200 F, as it comes from the brew kettle, to 45 F, are also completely instrumentated. The panel board for this operation includes a recorder-controller for controlling the flow of city water through the water sections of the cooler, while other recorder-controllers regulate the flow of ammonia through the ammonia section of the wort cooler. Indicating gages for the ammonia pressure, wort temperature indicators, and wort temperature recorders, as well as push buttons for the control of water booster pumps and ventilating fan are also located on this board.

In addition, this control panel houses switches to control the flow of hot wort over the cooler and a complete system of switches to control the air-actuated dampers in the air-conditioning ducts to and from the wort cooler rooms. A complete intercommunication system, including signals and telephones has also been installed to provide instant communication with workers on various floors of the brew house, as well as engineering department employes.

In the beer cooler rooms, recorder-controllers and back pressure valves are employed to maintain a constant temperature, while in the ageing cellars, accurate temperature controls are also maintained by the use of these instruments. They are so connected that they actuate the ammonia back pressure valves in the ammonia suction lines of each air-conditioning unit. Defrosting of the cellar air-conditioning equipment is automatic.

LIST OF PRINCIPAL STEAM GENERATING AND REFRIGERATION EQUIPMENT

Boiler	The Babcock and Wilcox Co
Oil-gas burner	The Babcock and Wilcox Co
Combustion controls	Republic Flow Meters Co
Feedwater regulator	T. J. Cope, Inc
Deaerator	Cochrane Corp
Feedwater pumps	Union Steam Pump Co
Feedwater pump turbine	Elliott Co
Boiler level indicator	Yarnall-Waring Co
Steam flow meter	Cochrane Corp
Ammonia compressor	Frick Co
Ammonia compressor	The Vilter Mfg Co
Ammonia compressor turbine	Elliott Co.
Cooling tower	The Marley Co., Inc.
Carbon dioxide compressor	Zahm and Nagel Co., Inc
Refrigeration pressure recorders	Taylor Instrument Co
Back pressure valves	A. W. Cash Co

AUTOMATIC COMBUSTION CONTROL FOR OIL BURNERS

Thorough atomization, uniform viscosity and correct fuel-air ratio are the fundamental considerations on any oil burning installation. Here is a discussion of methods for correlating automatic combustion control systems with various types of oil burners to achieve desired results

WILLIAM H. PUGSLEY
Vice President in Charge of Field Research
The Hays Corporation

ATOMIZATION is the mechanically breaking up or separation of a liquid into small individual particles. When burning oil, the purpose of atomization is to allow air (oxygen) for combustion to quickly surround each particle of oil. Then rapidity of ignition and subsequent combustion determines to a large extent the maximum flame temperature and the amount of excess air required.

Four basic burner types are used to atomize oil: (a) air atomizing, (b) steam atomizing, (c) rotary cup, and (d) mechanical pressure atomizing. Pressure atomizing burners can be classified further as either the tip changing or wide range type. With all of these types, the oil to be burned, especially the heavy grades, usually is preheated to provide uniform viscosity and to secure complete atomization.

Air Atomizing Burners

Air atomizing burners, one of the first types used for liquid fuel firing, require a source of compressed air. This factor has limited their application in central station and large industrial boilers, and air atomization is employed mainly for package units.

In operation, the oil is pulverized by air jets within the core of the nozzle, and the resultant air-oil emulsion is introduced to the furnace as a fog which ignites quickly. Usually, the oil pressure is somewhat higher than the air pressure although both pressures are maintained at relatively low values by automatic controls.

Steam Atomizing Burners

When steam is used for atomization, it is brought into contact with the oil in a specially designed burner and the mixture then passes through a nozzle or sprayer plate that reduces the oil to a fine mist. In most cases, the steam is controlled to a pressure slightly in excess of oil pressure. A comparatively wide range of operation is obtainable from this type of burner by varying the oil and steam pressures at the burner but without changing the sprayer plate. Both oil and steam are regulated automatically by the combustion control system. Generally, this type of burner is operated continuously although its use for intermittent service is increasing.

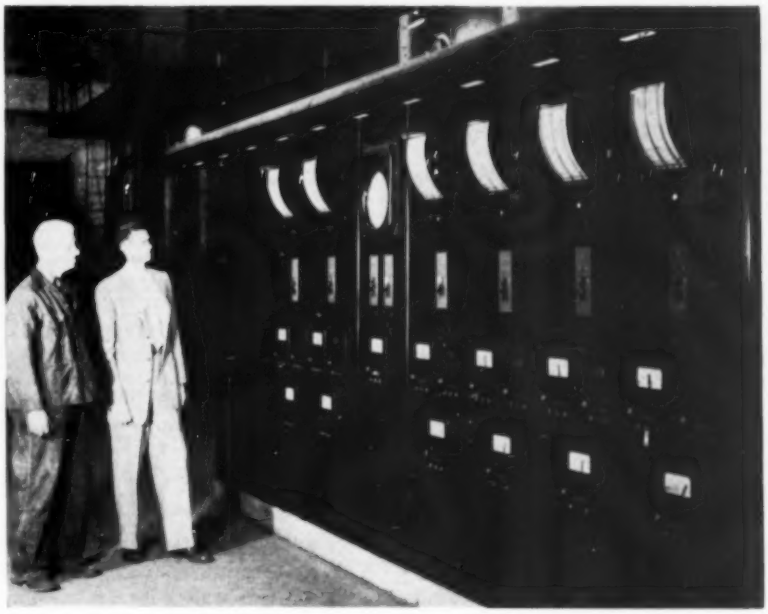
Rotary Cup Burners

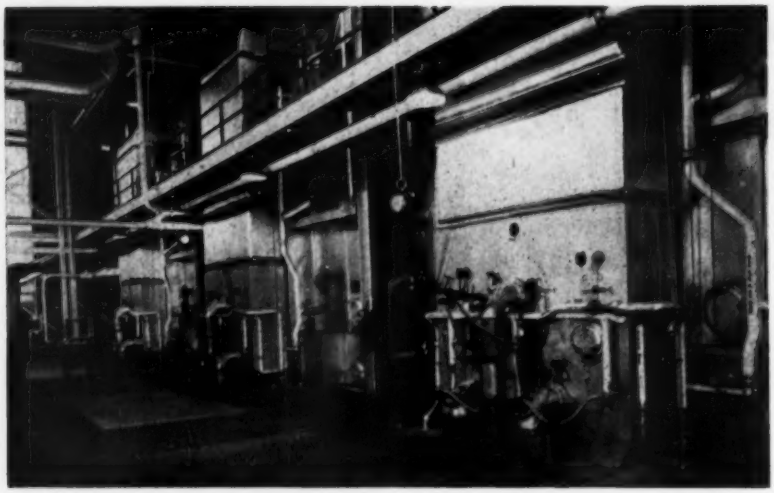
In the rotary cup design, oil under moderate pressure flows to the burner through a flow control valve and discharges inside a cup rotating at high speed. As the oil leaves the edge of the cup, which faces into the furnace, it is atomized by the high peripheral cup speed and forms a swirling cone.

Usually with this method of atomization, a small quantity of high pressure air is introduced through a cone shaped nozzle that surrounds the cone of atomized oil. The purpose of this is to cause turbulence and thereby rapidly mix the air and oil for immediate ignition. Additional air required for complete combustion is admitted through one or more openings directly beneath the burner and through refractory checker work in the floor.

This type of burner is used sometimes for automatic operation on an intermittent cycle when equipped with proper ignition and starting equipment. It also may be operated with a

Control panel, which will serve eight boilers with mechanical atomizing oil burners when completed, has master controller in the center and individual fuel feed, air flow, and furnace draft controllers for each unit on the sides





These steam generators are equipped with steam atomizing burners. Notations on the pipe covering show fluid content and direction of flow in each line

high-low flame in which case the high flame will produce more heat than required for the steam to be generated and the low flame less heat than required. Transfer from one rate of combustion to the other is controlled automatically. When the rate of combustion is regulated to equal the rate of steam generated, control of the oil, primary air and secondary air is accomplished automatically by a master steam pressure controller.

Pressure atomizing oil burners are of two general types: (a) tip changing type, in which the tip or sprayer plate is changed for different firing rates, and (b) wide range type, which can be used for an extremely wide range of steam generation without changing the tip or sprayer plate.

Tip Changing Burners

Tip changing type burners are controlled by varying the oil pressure through a range from the minimum at which atomization will take place to the maximum that the pumping system will supply. Since the range of firing rates that can be obtained by changing the pressure is very small for any one size sprayer plate, it becomes necessary to change sprayer plates and adjust the oil pressure for various load conditions. By controlling the oil from measurement of its flow, the size of tips used or number of burners in operation is automatically compensated for without making any manual adjustments.

Wide Range Burners

Wide range burners are built in several different designs. One type consists of two pressure burners combined into one with oil to each controlled separately so one or both burners can be utilized as needed. This design provides a wide oil burning range without changing sprayer plates.

Another burner that has a very wide capacity range is the return flow design. Oil is supplied to this type of burner at constant pressure and flows through a tangential plate at the tip into a whirl chamber. Here it can pass to the furnace through the sprayer plate or to the oil pump or heater through a return flow passage in the burner and connecting piping. With this arrangement, the quantity of oil burned is directly proportional to the pressure in the return line over the normal operating range of the burner. Therefore, this pressure is used as a measurement of oil flow to the furnace, and the automatic combustion control system positions a valve in the return line to regulate the pressure in accordance with the steam demand.

Air Registers

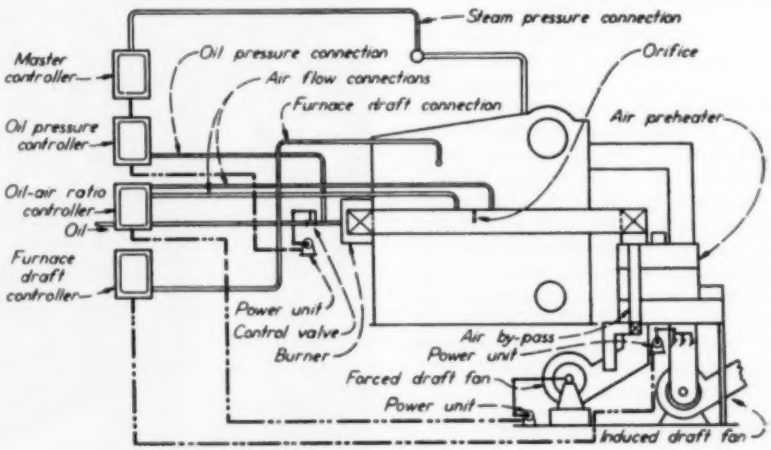
In order that combustion may take place, all burners have registers which serve the purpose of admitting and directing air so it will come in contact with the oil. The design or construction of the register has no effect on the method of control used since the vanes, spreaders or louvres are arranged for manual operation and should be allowed to remain so. This applies to both natural draft and forced draft air flow arrangements.

Natural Draft Operation

When air for combustion is supplied by natural draft, the preferred method for controlling air flow is to operate the boiler outlet damper. This assures the lowest possible furnace draft for all ratings and therefore reduces air infiltration to the minimum. Of course, furnace draft must increase with rating to provide the necessary additional air. Rotary cup burners nearly always operate on natural draft and have dampers directly beneath the burner to control the secondary air volume. With this arrangement, constant furnace draft can be maintained while load variations are compensated for by operating the secondary damper.

Forced Draft Operation

Where forced draft operation is employed, the air for combustion is supplied under pressure. In this case, a furnace draft controller should be used for independent control of the boiler outlet damper. Primary air flow is adjusted separately by positioning the outlet damper or inlet vanes on the



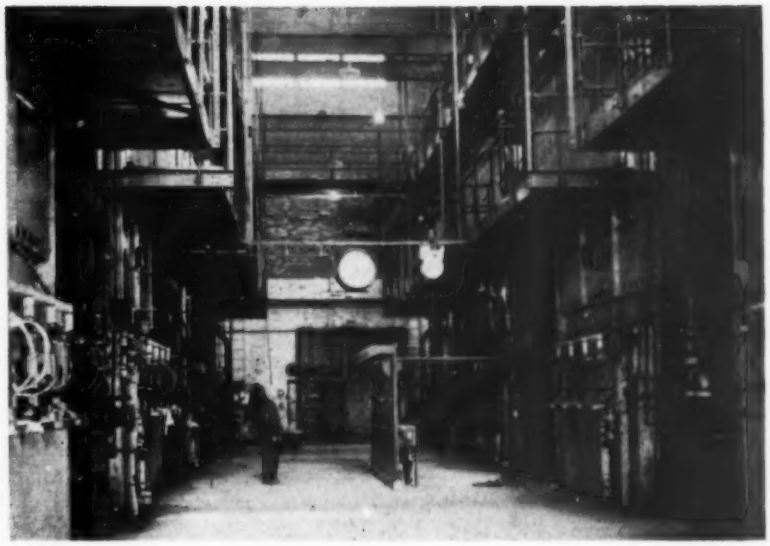
Control systems for steam atomizing burners often use a differential valve to maintain a constant difference between steam pressure and oil pressure

forced draft fan or by regulating the speed of the forced draft fan.

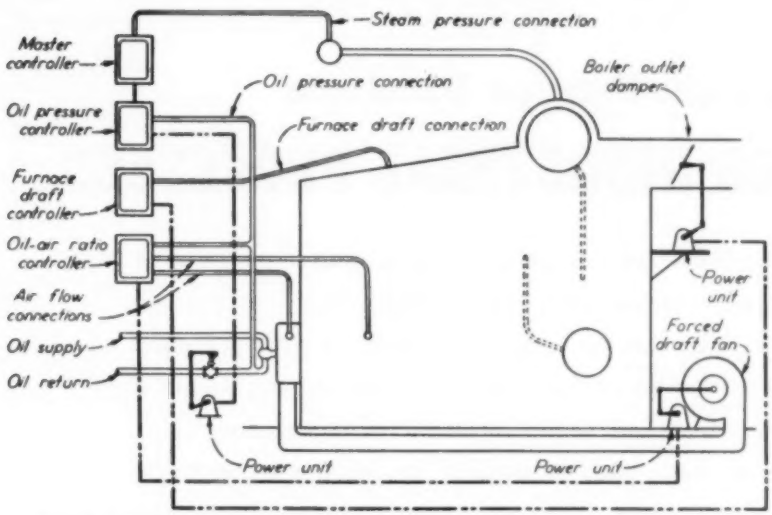
Off and On Type Control

Most off and on type controls are actuated by pressure switches or thermostats. Safety devices, such as low water cutout, stack switches, and ignition or flame failure controls, also are incorporated in these systems. Many times, off and on circuits have no provisions for controlling the combustion chamber draft or operating the boiler outlet damper. This condition can be eliminated by using a furnace draft controller to maintain constant minimum furnace draft both while the burner is off as well as when it is in operation. Any such device must be safe in operation, however, since all installations of this type are governed by regulations that do not permit the use of an outlet damper unless it is positioned automatically by an approved controller.

Positioning or metering type controllers sometimes are combined with off and on controls to form a fully automatic system. With such automatic combinations, the furnaces are operated off and on for light loads and continuously at higher loads. These systems also require protective devices for safety of operation and usually are applied to package boilers.



Boilers in this plant are fired by wide range mechanical pressure atomizing burners. Details of the automatic combustion control panel appear on page 69



Drawing shows typical arrangement of metering system of combustion control applied to boiler equipped with wide range burners having oil return lines

Positioning Control

Positioning control is used only for continuous operation of the smaller size steam generators. When burners are of the natural draft type, only a master controller operating from steam pressure is required to position the oil control valve and boiler outlet damper. However, manual adjustment is required frequently with changes in load in order to compensate for changes in sprayer plate size, number of burners in operation, and differences in valve and damper characteristics. When forced draft is used, a furnace draft controller is required in addition to the master controller.

Metering Control

The metering type of control system is most suitable for use with steam and pressure atomizing type burners because of the better results that can be secured and the ease with which it can be applied to oil firing. Generally the system consists of a master pressure controller which responds to changes in steam pressure as indicating a change in load on the steam generator. This controller establishes oil flow to each boiler through a fuel feed controller. A ratio controller, which measures oil flow and proportions air flow to oil flow, governs the flow of air for combustion. A furnace draft controller operating independently of these controllers maintains constant furnace draft. When steam atomizing systems are controlled, a differential valve is used frequently to hold a fixed difference between steam pressure and oil pressure at the burners.

Safety Devices

Various safety controllers can be incorporated as part of or to operate in conjunction with automatic combustion control systems. A load limiting controller that limits the rate of combustion (and therefore, the load which the boiler can carry) to prevent an unsafe furnace draft is a worthwhile protection against too low or loss of induced draft. A fuel-air ratio limiting controller, which prevents too high a rate of fuel flow for the flow of combustion air, protects against insufficient air for combustion as would result from failure of the forced draft fan. Low oil pressure and similar safety devices also can be added to the system for complete protection against unexpected operating irregularities.

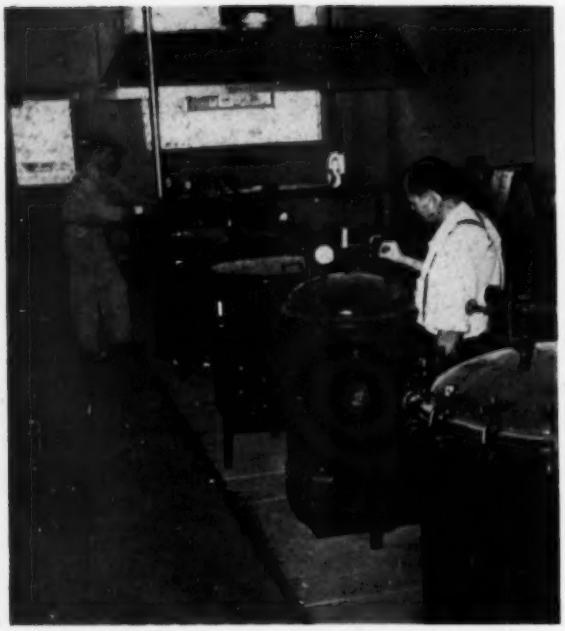


Fig. 1—Vacuum tanks are installed at Northrup Aircraft Company to impregnate metal castings with sealants and corrosion inhibitors such as the phenolic plastic resins

Fig. 2—A diesel locomotive armature is impregnated in a vacuum tank in the shops of the Atchison, Topeka & Santa Fe Railway. These applications do not need extreme vacuum

Modern, High Vacuum Pumps Produce "NOTHING" FOR INDUSTRIAL PROCESSES

Vacuum pumps are not basically new for low pressures have been produced in laboratories for many years. Commercially, vacuum processing is at least as old as the incandescent lamp. But the impetus supplied by radar, nuclear energy and television has made high vacuum equipment common and practical for industrial plants. Many new and somewhat surprising applications have been uncovered. Here is a picture story of some of the equipment and installations used, with brief descriptions of common processes given in the text

FRANK CHARITY

SOMETHING FOR NOTHING is, figuratively, obtained with modern high vacuum processing equipment. There are many potential applications for such equipment because it is still new and quite versatile in its industrial form.

Most industrial organizations of today have compressors which can be used as vacuum pumps in reducing pressures to about 29 in. Hg. But that is what engineers now regard as a "low vacuum", leaving about one-thirtieth of the gas in the evacuated chamber. It is good enough for degassing certain types of castings and the like, but is not adequate for many processing requirements.

A high vacuum involves the production of pressures in the 29 to 30 in. range, 30 in. Hg (29.921 in. for standard conditions) being a perfect vacuum. No one has yet been able to produce a perfect vacuum with man-made equipment. But with industrial vacuum pumps now available pressures can be reduced to as little as one micron (0.00002 psi, or about 1.5 ppm of gas) without exorbitant investment in terms of time and equipment.

Vacuum pumps include reciprocating types, rotary oil pumps, steam jet air ejectors and the like, each varying in degree of vacuum attainable and in pumping speed. But for high speed operation at very low pressures, the multistage diffusion pump, illustrated in Fig. 4, is most practical.

In the diffusion pump, mercury or oil is vaporized in a boiler at the bottom. The vapor rises through a chimney to a jet in the inlet passage connected to the container being evacuated. Escaping from the orifice at supersonic speeds in the direction at which a forepump draws gas, the vapor entrains gas molecules from the container, impelling them towards the next stage or towards the forepump. The vapor condenses on the

cooled wall of the pump and returns to the boiler to repeat the cycle.

The pressure possible is limited by the vapor pressure of the liquid used at the temperature of the cooling walls. For extremely low pressures, a cold trap, cooled with dry ice or liquid air or other gas is installed in the inlet passage. Diffusion pumps are most efficient at low pressures and the forepump is required for that reason. Furthermore, reduction per stage is limited and the multistage pump is necessary for high speed pumping to low pressures.

Vacuum pumps are used for many applications such as:

1. Create an inert atmosphere for sintering, heat treating, brazing, or melting materials such as magnesium and titanium without appreciable oxidation or combustion.

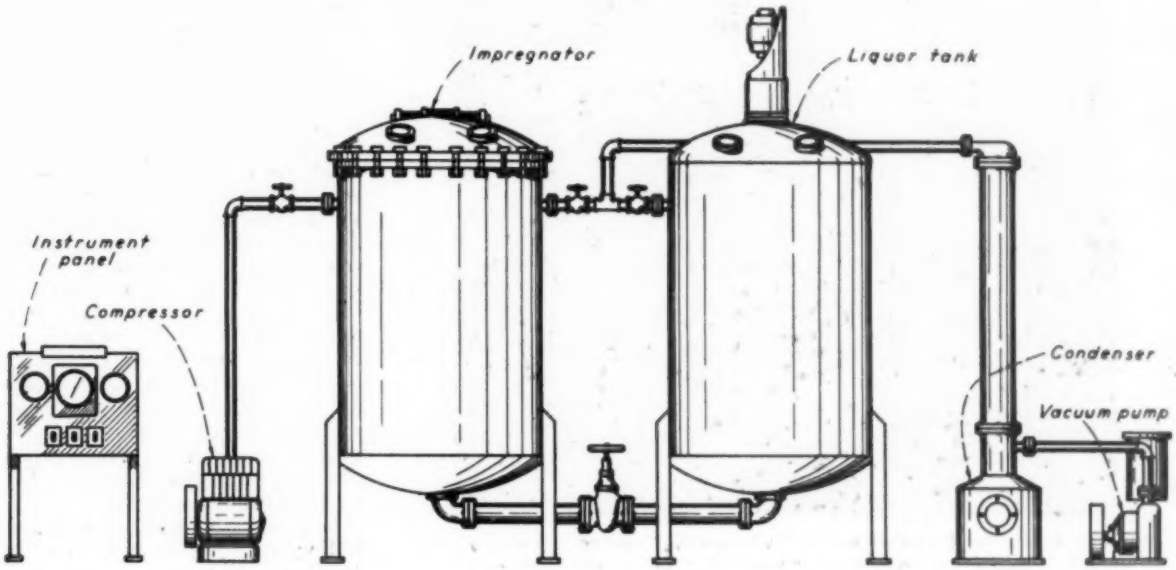
2. Impregnate or seal a metal casting, armature, coil, condenser, or similar component.

3. Package a perishable product in an airtight container so that it will not deteriorate for a long period of time.

4. Apply, without oxidation and roughness, a pure metallic coating with dimensionally precise thicknesses ranging upward from about a millionth of an inch on a metallic or nonmetallic surface.

5. Manufacture vacuum tubes, thermos bottles, or related products.

For the first of the above applications, the vacuum chamber is actually an airtight furnace. It usually has elec-



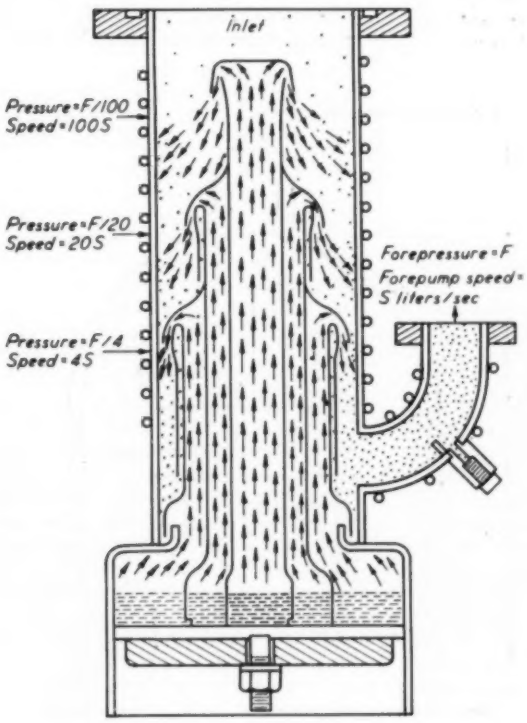


Fig. 3 (above)—Schematic view of impregnator installation

Fig. 4 (left)—The modern, all-metal, multistage diffusion pump has extended applications for industrial high vacuum processing. Each stage operates like a steam jet air ejector, produces successively higher vacuum. Oil or mercury is boiled in bottom chamber and vapor expands downward through nozzles, drawing gas molecules with it. Vapor condenses on cooled pump walls. Inlet vacuum is limited by vapor pressure of the liquid used. Note that an auxiliary forepump is needed to reduce outlet pressure to low value

Fig. 5 (below)—One of the smallest diffusion pumps being manufactured is employed in the production of vacuum tubes

Fig. 6—An installation of one of the larger high vacuum processing units is used for production of evaporation coatings but it could be adapted for other uses. The diffusion pump is mounted below the bell jar and the forepump can be partially seen in the lower left corner in the illustration. Evaporation coatings have applications and characteristics often impossible to obtain with electroplated types

trical heating elements since other types would have to be installed in separate compartments to get the oxygen required for efficient operation. When the vacuum furnace is loaded and closed, air is withdrawn from the central compartment with a high vacuum pump. Then, as a rule, an inert gas such as argon or helium is pumped into the compartment with a more or less conventional compressor. Heavier-than-air gases are often preferred for these operations, since they will cause any air remaining in the compartment to rise above the materials or parts that must be heated.

A vacuum chamber without heating accessories is usually suitable for operations of the second type. When the chamber is loaded and closed, air is evacuated as noted above. Then a line leading to a storage tank, Fig. 3, is opened, so that a liquid impregnant will flow into the vacuum chamber and submerge the materials or parts to be impregnated. Excellent wetting action is thus attained, due to the absence of air and moisture in the pores of the materials or parts. (Gases or moisture, either absorbed or adsorbed, would otherwise be sealed in by the impregnant or retard capillary flow. Free gas in the cavities would form bubbles.)

In some cases the vacuum is released as soon as the parts are submerged. Wetting action can often be further accelerated by atmospheric pressure or by pumping compressed air into the area in the chamber above the impregnant helping force viscous liquids through small openings.

Packaging applications for high vacuum equipment are both numerous and varied. In most circumstances, containers are situated in a vacuum chamber containing a mechanism with which they can be sealed as soon as all air is withdrawn. In other circumstances, containers themselves are individually evacuated so that lubricants and other preservatives can be used to submerge contents prior to sealing.

High vacuum coating techniques at present include cathode sputtering and evaporation processes. Each usually necessitates withdrawal of air from a vacuum chamber. An inert gaseous atmosphere can be substituted for the purpose of preventing the oxidation of coating materials or improving electrical discharge characteristics.

In the cathode sputtering process, a high voltage (1000 to 20,000 v a-c or d-c) is applied to two or more electrodes which are situated so as to form an electrical discharge system. Current passing between the electrodes causes

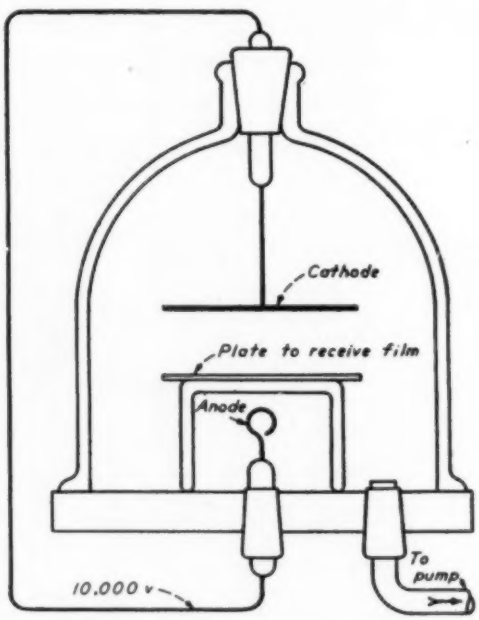


Fig. 7—In the cathode sputtering process, the pressure is reduced until the gas is ionized by the high potential applied between the electrodes, and is held at a value at which the cathode drop causes the material to be ejected. The cathode material is subsequently deposited on the plate positioned between the two electrodes

the cathode surface to sputter or disintegrate, depositing metallic material on a surface beneath it, Fig. 7. Resultant coatings may comprise selenium, tungsten, aluminum, and many other elements or alloys. Their adhesion to a surface depends on their purpose and the method whereby they are applied. For example:

1. In fabrication of dies for the compression molding of phonograph records, metal coatings are cathode sputtered on wax masters so that the latter will have the electrical conductivity required to electroform dimensionally precise mold cavities thereon. Masters and cavities can then be separated without difficulty to permit use of the cavities as production tools because the metal and wax surfaces have no tendency to adhere permanently.

2. In the production of "super-reflectors" for telescopes and other optical instruments, glass materials are first immaculately cleaned and then metallized with cathode sputtering equipment. Careful cleaning makes it possible for the coatings (which usually comprise pure aluminum) to adhere permanently to the glass surfaces. Superior reflectors are thus obtained because the coatings have a better luster and more durability than the silver coatings that are applied to ordinary mirrors by chemical methods.

Evaporation coatings are considered superior to cathode sputtered coatings for many purposes because they can be applied more smoothly and with greater dimensional accuracy. Their production briefly involves the vaporization of a coating material in an inert atmosphere, so that the material will be deposited on metallic or nonmetallic surfaces (like steam from boiling water) without oxidizing.

The vaporization is attained by placing coating materials in electrical coils or crucibles. Power required varies between 1 to 135 v and 5 to 400 amp of current. But no appreciable heat is conveyed to coated surfaces by the vaporized coating particles because they are of molecular dimensions and subject to rapid chilling.

An evaporation coating may comprise almost any metal or metallic oxide. Despite the normal opacity of such coating materials, it may be either transparent or opaque, depending on thickness of the deposited layer. Coatings with thicknesses ranging upward from a millionth of an inch are precisely obtained by limiting amount of time during which evaporation takes place. The permanency of their adhesion depends on the same considerations that have been mentioned in connection with cathode sputtering. Typical applications include:

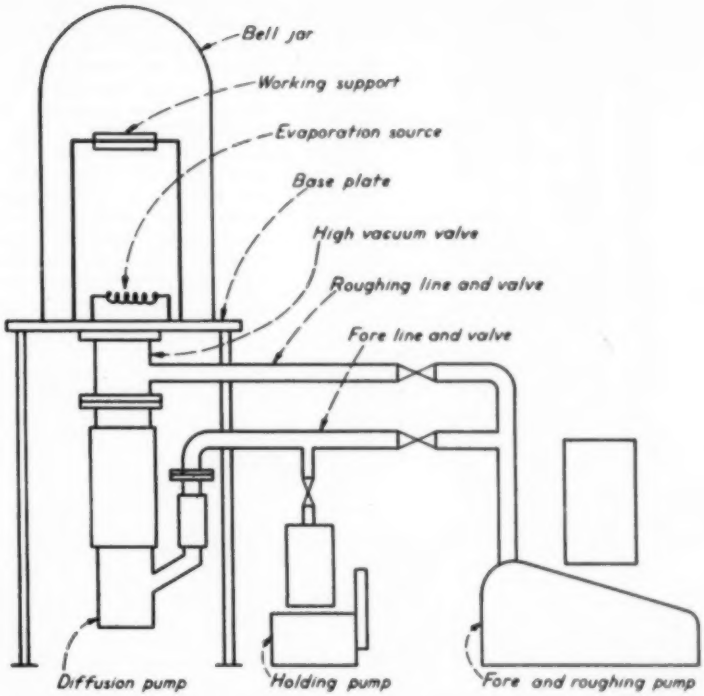


Fig. 8—The schematic arrangement of components used in evaporation coating processes is similar to that for cathode sputtering except for equipment within the bell jar. The roughing line enables preliminary evacuation with the diffusion pump bypassed for large quantities of air

1. Functional (anti-reflective) finishing of lenses for cameras and other optical devices. Coatings of this type are usually transparent, having thicknesses in the neighborhood of five millionths of an inch. Their purpose is to improve the ability of glass materials to conduct light by minimizing reflections.

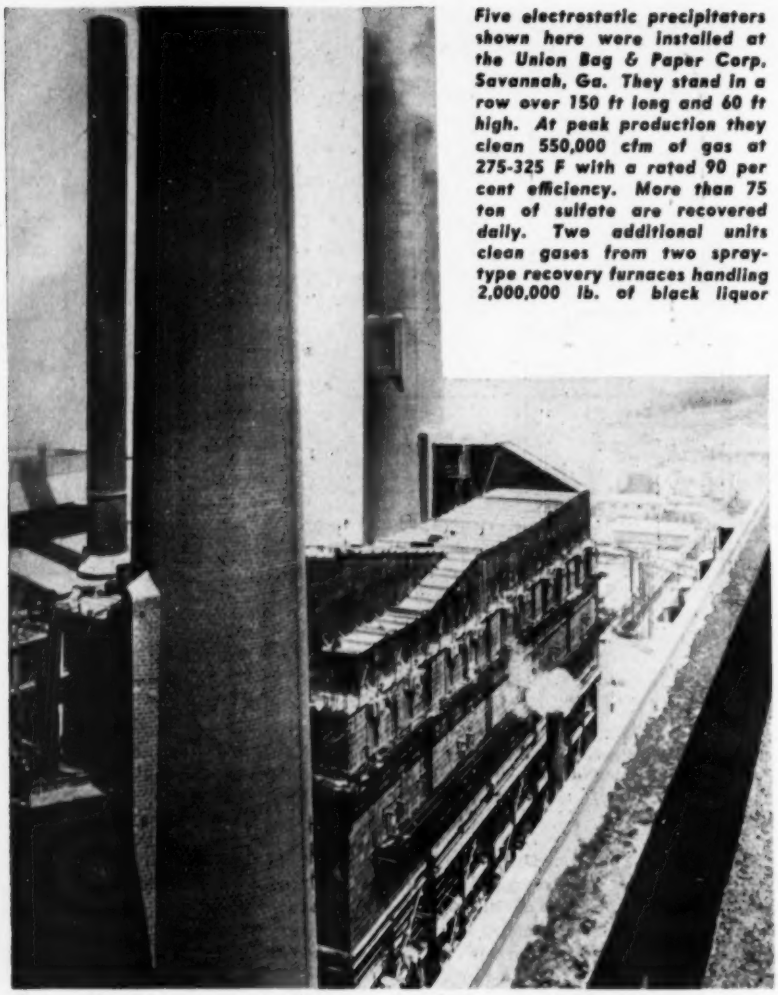
2. Opaque metallizing of plastics, paper, leather, ceramics and the like for decorative effects. This is economical because the adhesion of coating materials is not dependent on electrochemical compatibility, and because a small quantity of metal will opaquely cover large surface areas in a relatively short period of time. For example, an ounce of pure aluminum can be used to cover more than 1500 sq ft of paper without substantially reducing its flexibility. Opaque evaporation coatings, incidentally, do not require the buffing and polishing essential to obtain brightness in electroplated coatings.

3. Protective coating of metal and nonmetal products to produce, for example, greater surface hardness or better resistance to corrosion. Evaporation coatings of this type can be applied in less time than electroplated coatings and without regard for the electrochemical compatibility of coating materials and base materials.

In the manufacture of products such as vacuum tubes and thermos bottles, high vacuum pumps are used much the same as conventional vacuum pumps and are primarily advantageous to the extent that they improve the qualities of the finished products by making it possible to remove more air.

Use of a high vacuum pump where a conventional pump will meet all foreseeable requirements is not advisable from an economic point of view. For, regardless of the fact that differences in initial equipment costs are not usually great, high vacuum units often require relatively high installation and maintenance expense.

Vacuum chambers and other accessories essential to successful use of high vacuum pumps must naturally be made to order where certain unusual processing requirements prevail. However, it is encouraging to note that most items in this category can be economically purchased as standardized units from most pump manufacturers for many practical purposes. Said manufacturers currently include F. J. Stokes Machine Co., Philadelphia; Central Scientific Co., Chicago; Distillation Products Industries, Rochester, N. Y.; Process Industries Engineers, Inc., Pittsburgh; and the new High Vacuum Equipment Corp., Hingham, Mass.



Five electrostatic precipitaters shown here were installed at the Union Bag & Paper Corp. Savannah, Ga. They stand in a row over 150 ft long and 60 ft high. At peak production they clean 550,000 cfm of gas at 275-325 F with a rated 90 per cent efficiency. More than 75 ton of sulfate are recovered daily. Two additional units clean gases from two spray-type recovery furnaces handling 2,000,000 lb. of black liquor

FLY ASH COLLECTOR TREND

• • • • • has been toward an ever increasing collector efficiency in regard to the smaller particle size. Manufacturing and steam power plants alike have steadily installed better equipment

H. W. MOORE and H. L. RICHARDSON

Research Corporation

MUCH has been said and written in the past twelve months about smoke and air pollution, and what should be done to alleviate it. Municipal authorities in cities throughout the country have taken steps aimed at enforcement of smoke abatement programs.

Power plant engineers do not find themselves confronted with any new problems as a result of this recent activity, which seeks to reduce the smoke nuisance. That public utilities have long been cognizant of the need for fly ash elimination as indicated by the fact that the first electrostatic precipitator was installed for this purpose in 1923.

Today, electrostatic fly ash collectors form an integral part of many pulverized coal-fired boiler installations. They are included in power plants chiefly because management appreciates the importance of public relations and community responsibility.

Magnitude of the fly ash problem is indicated by recently published figures covering the pulverized coal burned annually by utility companies alone, some 65,000,000 ton. On a reasonable basis of an average ash content of 10 per cent, the quantity of fly ash that could be emitted would be about 5,000,000 to 6,000,000 ton in one calendar year.

A large modern boiler producing, for example, 900,000 lb of steam per hr will exhaust flue gas at the rate of about 450,000 cfm at 300 to 400 F. With a fly ash concentration of 2 gr per cu ft, which is a common figure, the dust emission will be 130 lb per min or 92 ton per day. This example serves to illustrate the magnitude of the problem involved in preventing atmospheric pollution from this source.

At present there are no generally well-defined regulations as to the amount of dust that can be emitted without constituting a nuisance. The American Society of Mechanical Engineers has prepared example sections for smoke regulation ordinances looking toward realistic and economically possible control.

In general terms, the ASME code gives a maximum figure for dust emission of 0.85 lb per 1000 lb of gas, adjusted to 50 per cent excess air, and a maximum required collector efficiency of 85 per cent. In spite of this, most users of pulverized coal, and this applies particularly to the utilities, have set for themselves the objective of procuring equipment that will provide the highest possible collection of fly ash, both quantitatively and visually.

This situation has lead to the focusing of attention on electrostatic separation, which has the ability to remove at high efficiency from a moving gas stream all sizes of particles from submicroscopic to the largest present. It can be carried out in equipment, which has long, useful life, imposes relatively low draft loss, and can be incorporated in space available in most boiler installations. Other practical considerations combine to make it ideally suited for this operation.

Electrostatic precipitation has been employed in many applications other than fly ash separation. In many of these installations efficiencies in excess of 99 per cent in continuous commercial operation are not unusual. In ash separation, the conditions under which a collector must operate vary from installation to installation and in day-to-day operation. Inasmuch as it

is not ordinarily practicable to adjust these conditions for best collector operation, the precipitator must provide required performance under whatever conditions prevail.

Fly ash itself is a major variant. It is not a homogeneous or a uniform material. Physical and chemical properties vary widely, depending upon such factors as type of coal burned, type of furnace, furnace operation, and coal grinding conditions.

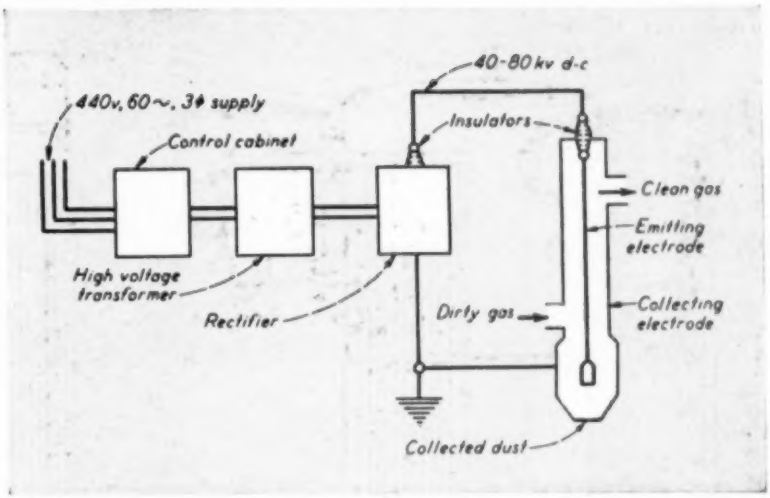
Table 1 shows the fly ash particle size analysis for ten actual samples taken recently from commercial operating precipitators. These data show that a high removal of extremely small particles is necessary in order to obtain a visually clean stack discharge.

Table 2 shows the computed average of seventeen fly ash samples tested in 1938-1939. The trend, therefore, appears to be toward finer and finer particles.

Table 3 shows a comparison of the guaranteed removal efficiencies for numerous precipitator installations made during the years 1936-1950, inclusive. In the five-year period 1936-1940, only 22 per cent of the installations specified over 92½ per cent fly ash removal efficiency. In the period 1941-1945, 60 per cent of the installations were above 92½ per cent efficiency.

Trend toward higher efficiencies as shown by the data in Table 3 is proof that power plant engineers in this country have been doing an increasingly better job of smoke elimination during the last decade, especially so in the years since the end of World War II.

Principle of electrical precipitation is neither complicated nor new. Its simplest demonstration is the familiar grade-school experiment with static electricity. Remember rubbing a rubber comb or fountain pen with a silk cloth and watching it attract dry dust or lint. An electrical precipitator is essentially the practical application of that elementary experiment.



Electrostatic precipitator consists of four basic elements: electrical control cabinet, high voltage transformer, direct current rectifier, and the collector

As early as 1771 observers noted the effect of electrical discharges through smoke-filled gases. Throughout subsequent generations many independent investigations were made of this principle, but due to the primitive nature of electrical generating devices, precipitation remained an interesting laboratory phenomenon. It was not until 1905 that Dr. Frederick Gardner Cottrell, Professor of Physical Chemistry at the University of California, concluded a series of laboratory experiments that resulted in the installation of the first commercial precipitator. The practical uses of this pilot unit soon led to others and to wide use of the process.

Function of a precipitator is to collect liquids and solids suspended in industrial gases. Smoke, for example, is a suspension of small, solid particles of such density that they can be seen. Remove these solids, and only the invisible gas remains. The cottrell electrical precipitator performs this function by placing electrical charges on the particles as they enter a strong electrical field.

In practice, two groups of equipment are required: the electrical apparatus for producing and controlling the high-voltage power, and the precipitator chamber in which the gas is treated.

Operating center of the system is a source of alternating current and a switchboard equipped with necessary meters and controls. Current flows from the switchboard to a high-tension transformer, which steps up the power supply to the required voltage for the particular purpose. This may be from 15,000 to 100,000 v or over. Since unidirectional current is essential, the stepped-up alternating current

TABLE 1 — DIAMETER OF PARTICLES IN MICRONS

Size	0-5	5-10	10-20	20-44	+44
Sample	Per cent	Per cent	Per cent	Per cent	Per cent
1	25	17	18.5	25.5	14
2	37	19	21	16	7
3	34	32	20	4	10
4	38	28	18	15	1
5	40	24	21	13	2
6	21	21	35	16	7
7	28	24	21	16	11
8	48	18	21	11	2
9	40	19	19	12	10
10	47	21	19	12	1
Average	35.8	22.3	21.4	14.1	6.5

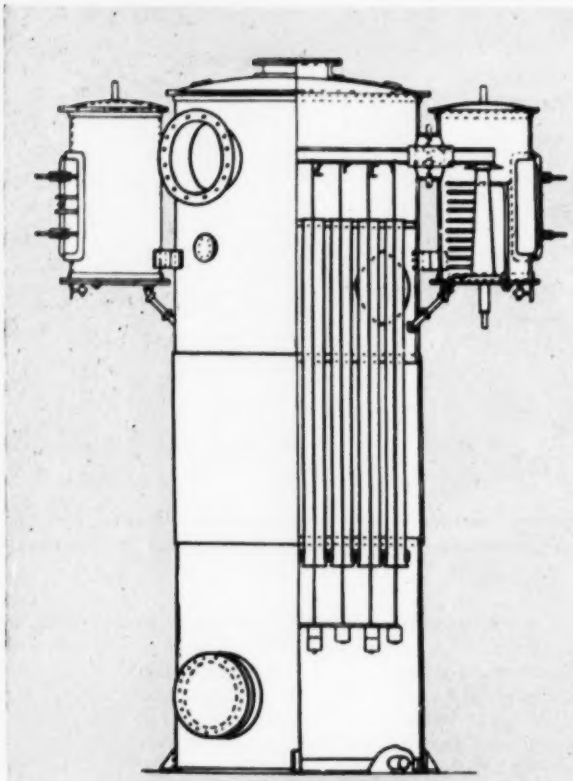
TABLE 2 — DIAMETER OF PARTICLES IN MICRONS 1938-1939

Size	0-5	5-10	10-20	20-40	+40
	Per cent	Per cent	Per cent	Per cent	Per cent
Average	11.91	17.66	27.08	18.65	24.70

TABLE 3 — TREND IN COLLECTOR EFFICIENCIES

Efficiency, per cent	Below 90	90-92½	92½-95	95-97½	Total
Year (inc)	Per cent	Per cent	Per cent	Per cent	Per cent
1936-1940	None	78	17	5	100
1941-1945	1	39	55	5	100
1946-1950	10*	21	47	22	100

*Includes precipitators in combination with mechanical collectors.



Simple pipe type precipitator has a number of pipes nested in a single shell under a header plate to remove particles

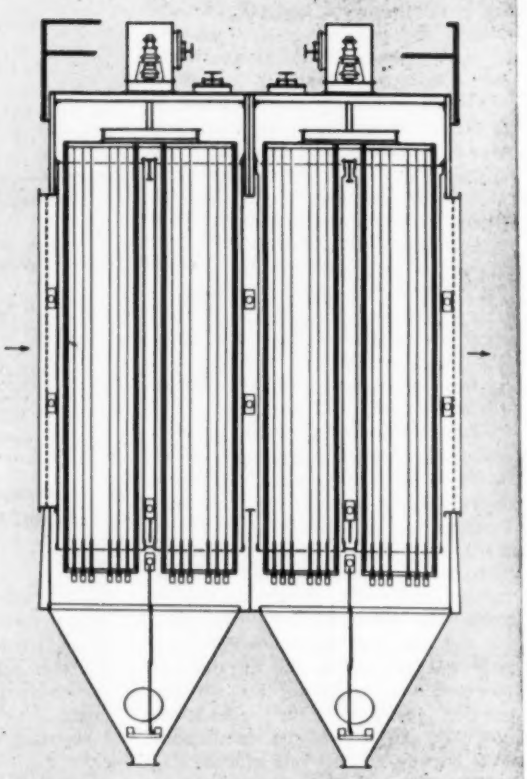


Plate type is employed primarily for removing dry dusts. It is comprised of parallel plates encased in a shell

from the transformer goes to a rectifier for conversion. The rectifier is mechanical, but this conversion can also be effected by electronic tubes. Where the original power supply is dc, it is necessary to convert to ac prior to raising the voltage and then rectifying back to dc.

A conductor, usually a specially designed high-voltage cable, carries the rectified current from the electrical set to the precipitator. A precipitator chamber is incorporated that consists of grounded collecting-electrodes — such as a pipe. Suspended in the central axis of this pipe is the dischage electrode, which is carried on insulators and connected to the source of the high-voltage current. The great difference in voltage between the discharge electrode and the collecting electrode sets up a powerful electrical field between them.

Gas, containing suspended particles, enters the chamber through the inlet flue at the bottom (left) and leaves through the outlet flue at the top (right). In so doing, it passes through the high-voltage electrical field impressed across the electrodes. In this field a uni-polar discharge is produced from the discharge electrode, and the gas ions thus formed attach themselves to the suspended particles. The resulting charged particles are attracted to the electrode of opposite sign. Here their charge is dissipated, and they become electrically inert. When a liquid, the material collected flows down from the collecting electrode. When a solid, the material is removed by special scraping, rapping, or washing devices. All materials are deposited into the hopper at the bottom of the chamber, from which they are easily removed for use or disposal.

Plate or duct type precipitators are used primarily for removal of dry dusts such as fly ash and are composed of a series of parallel plates encased in a shell, thus forming ducts or gas passages. The discharge electrodes are suspended in the centers of these ducts from an insulated framework.

Although this type of precipitator is typical of those used for fly ash recovery, each particular installation must be engineered to fit specific requirements. Special features of design and construction, therefore, are employed to produce optimum performance based on extensive experience and practice with this type of equipment in field.

In power plants, with recent advances in coal pulverization, the fly ash resulting from the firing of pulverized coal in boilers is so finely divided that only electrostatic precipitators provide the desired degree of gas cleaning. With precipitators today, 90 to 99 per cent of the total fly ash coming from hundreds of powdered fuel boilers is collected and prevented from entering the atmosphere.

Type of precipitator most generally employed for removal of fly ash in power plants is the horizontal flow plate unit. In establishing the design, there is always the problem of locating the precipitator within the boiler columns. Modern steam generation, with higher capacities in less space, makes it necessary to study each case at length in order to get adequate precipitation capacity into areas, which become smaller and smaller as the years go by. There are, of course, many more problems involved in specific installations. Electrical resistivity of the dust, gas velocity, and flue arrangements are important variables, which have to be taken into consideration.

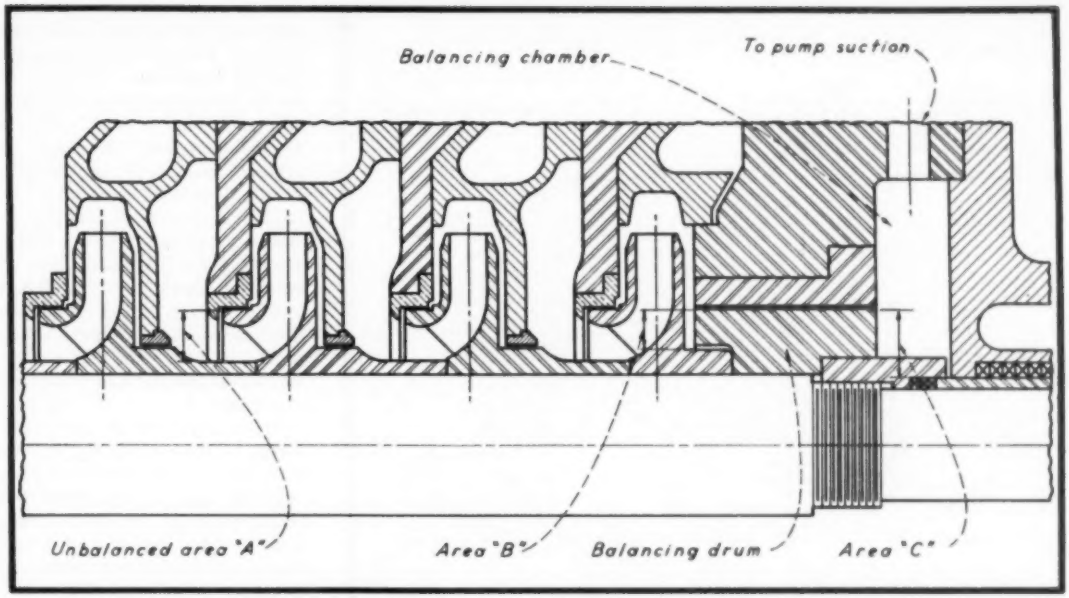


Fig. 1 — Balancing device rotates with shaft, and balancing chamber is connected to the pump suction

CENTRIFUGAL PUMPS

Hydraulic Balancing Devices

Here is a complete resume of how multistage centrifugal pumps are engineered to overcome axial thrust from rotating impellers. Principles of four methods of balancing this thrust are explained, and the advantages and disadvantages of each are enumerated

IGOR J. KARASSIK and ROY CARTER
Worthington Corporation

IN previous discussions, single suction impellers were said to be subjected to an axial hydraulic thrust due to the unbalance of pressures acting on its two faces. Should all the single suction impellers of a multistage pump face in the same direction, the total hydraulic axial thrust acting towards the suction end of the pump will be the sum of the individual impeller thrusts. The value in pounds will be approximately equal to the product of the total head generated by the pump in pounds per square inch and the annular unbalanced area in square inches. In order to balance this thrust, as well as to reduce the pressure on the stuffing box adjacent to the last stage impeller, some form of hydraulic balancing device must be used. This hydraulic balancing device may be a balancing drum, a balancing disc, or of a combination of both.

Balancing Drum

Operation of the balancing drum is illustrated schematically in Fig. 1. Balancing chamber at the back of the last stage impeller is separated from the pump interior by a drum keyed or screwed to the shaft. The drum rotates with the shaft and is separated by a small radial clearance from the stationary portion of the balancing device (called the balancing drum head), which is fixed to the pump casing. The balancing chamber is connected to the pump suction. By reason of this arrangement, the back pressure in the balancing chamber is but slightly higher than the suction pressure. Pressure differential between the two is equal to the friction losses between this chamber and the point of return. Leakage, which takes place between the drum and stationary portion of the balancing device, is of course a function of the differential pressure existing across the drum and of the clearance area available for the flow to take place.

Referring to Fig. 1, the forces acting on the balancing drum are as follows: a) towards the discharge end—discharge pressure times area B and b) towards the suction end—back pressure in the balancing chamber times area C.

Obviously the force (a) is greater than force (b) and will act to counterbalance axial thrust exerted upon the single suction impellers. Actually, the drum diameter can be so selected as to result in balancing this axial thrust either completely or within 90 to 95 per cent. This depends on whether or not carrying any portion of the axial thrust on the thrust bearing is desired.

For the purpose of simplification in the preceding description an assump-

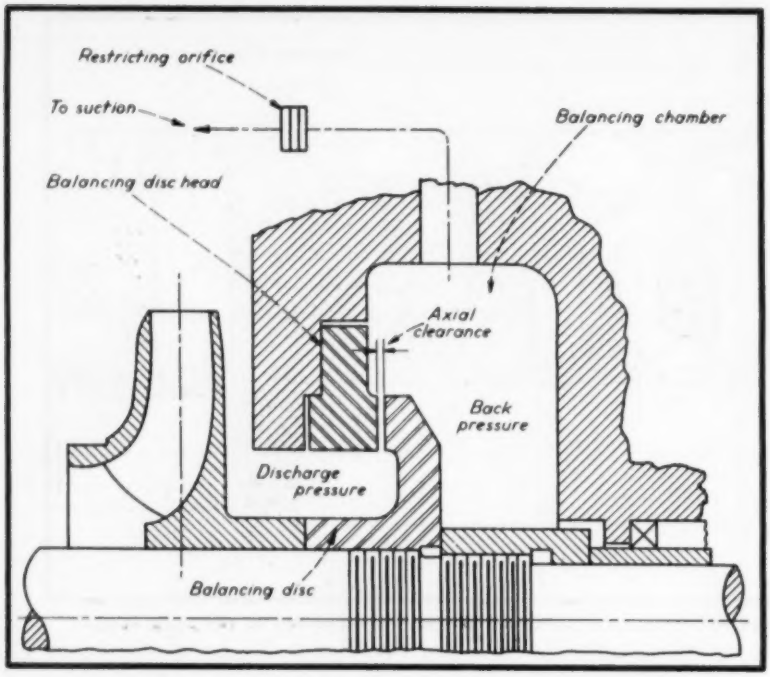


Fig. 2—Simple balancing disc is fixed to the shaft. Leakage is between the disc and disc head. Chamber is equalized with suction

tion was made that the pressure acting on the impeller walls is constant over the entire surface of these walls, and that the axial thrust is equivalent to the product of the total net pressure generated and area "A". Actually, this pressure varies somewhat in the radial direction because of the centrifugal force exerted upon the water by the rotating impeller. Further, the pressures at a corresponding point on the opposite faces of an impeller need not be necessarily equal to possible variation in the clearance between the impeller wall and the portion of the casing separating successive stages.

Finally, distribution of the pressure over the impeller wall surface may vary with the head and capacity operating conditions. This pressure distribution and design data can be determined quite accurately from test for any one fixed operating condition of head and capacity. Thus, a balancing drum could be designed on the basis of the forces resulting from the pressure distribution thus determined. Unfortunately, any other conditions of head and capacity entail changes in pressure distribution. Since balancing drum area is necessarily fixed, an ubalanced condition might result that can destroy the axial force equilibrium.

Objectionable feature of this is not primarily the amount of the thrust, but the fact that its direction cannot be predetermined due to the uncertainty of the internal pressures. Knowing beforehand in what direction the thrust will be exerted normally is advisable, since this may be a determining factor in fixing the external mechanical thrust bearing design. For these reasons, frequently designing the balancing drum to balance about 90 or 95 per cent of the impeller thrust has been the practice, since a perfect balance cannot be attained, and the slight unbalance can be carried by the thrust bearing.

In order to reduce balancing drum leakage, a series of steps along the drum are sometimes provided, and small relief chambers interspersed at each step. In addition, the drum surface has been frequently formed with serrations, which have been found to give longer life than the straight piston type drum.

Balancing drums fulfill satisfactorily the requirements of balancing axial thrust of single suction impellers and of reducing pressure on the discharge side stuffing box. It lacks, however, the virture of automatically compensating for any changes in axial thrust imposed by impellers. This automatic compensation is the major feature, which differentiates the balancing drum from the balancing disc.

Balancing Disc

The simple balancing disc, Fig 2, is fixed to and rotates with the shaft and is separated from the balancing disc head by a small axial clearance. Leakage through this clearance flows into the balancing chamber and thence to the pump suction just as in the case of the balancing drum. The back of the balancing disc is subject to back pressure in the balancing chamber. Face of the disc is acted upon by an intermediate pressure, which is equal to the discharge pressure at the smallest diameter of the disc and to back pressure at its periphery. Inner and outer disc and diameters are so chosen that the difference between total force acting on the disc face and that acting on its back balance axial thrust exerted upon impellers.

If at any time in operation axial thrust of the impellers should exceed the force acting on the disc in the opposite direction, the latter is moved towards the disc head, reducing axial clearance between the disc and disc head. Amount of leakage through the clearance is reduced with the result that friction losses in the return line are also reduced, thus lowering back pressure in the balancing chamber. This automatically increases the pressure difference acting on the disc and moves it away from the disc head, increasing the clearance. Now, pressure builds up in the balancing chamber, and the disc is again moved towards the disc head until an equalibrium is reached when the thrust forces balance in both directions.

In order to insure this sequence of events, variations in the back pressure that take place in the balancing chamber of necessity must be of an appreciable magnitude. Thus with the balancing disc in its wide open position, with respect to the disc head, back pressure must be substantially in excess of suction pressure. This is true in order that the reduction of the resultant force acting on the disc towards the discharge end by sufficient to restore the disc towards its normal position. This can be accomplished by introduction of a restricting orifice in the return line to the suction that acts to build up back pressure should leakage past the disc increase beyond normal. However, the balancing chamber is considered as being sealed by a stuffing box, and variation in pressure in the balancing chamber is a condition that is injurious to the life of the stuffing box packing. Further, the higher pressure, which, under certain operating conditions, will prevail at the packing is also undesirable.

Combination Disc and Drum

For these reasons, the simple balancing disc is seldom used. The combination balancing disc and balancing drum was developed to obviate the

shortcomings of the disc while retaining the advantage of an automatic compensation for changes in the magnitude of the axial thrust.

Roatating portion of the balancing device consists of a long cylindrical body, which rotates within the drum portion of the disc head, followed by a disc similar to the one previously described. Radial clearance is, of course, constant regardless of disc position while axial clearance varies with axial position of the pump rotor. Forces acting towards the discharge end are the sum of the discharge pressure times area "A" plus the average intermediate pressure times area "B", while the force acting towards the suction end is the back pressure times area "C", (Fig 3).

While the *position-restoring* features of the simple balancing disc was based on the wide variation of the back pressure, which must be kept as nearly a constant value as possible, it now becomes possible to depend upon a variation in the intermediate pressure to achieve the same effect. This is accomplished in the following manner: when the pump rotor moves towards the suction end (to the left, Fig. 3) because of an increased axial thrust, axial clearance is reduced and pressure builds up in the intermediate relief chamber. This increases the average value of the intermediate pressure acting on area "B". In other words, with a reduced leakage, pressure drop through the constant radial clearance decreases, increasing pressure drop across the axial clearance. The increase in the intermediate pressure forces the balancing disc towards the discharge end (to the right, Fig. 3) until an equilibrium is reached. Movement of pump rotor towards the discharge end would have the effect of increasing axial clearance, increasing leakage and decreasing intermediate pressure acting on area "B".

Modifications

These are the basic types of hydraulic balancing devices, and, obviously, there are in use numerous modifications of the principles embodied in their design. One such typical modification consists of separating the drum portion of a combination device into two halves, one of which precedes and the second follows the disc itself, (Fig. 4). Virtue of such an arrangement is to provide a definite cushioning effect at the intermediate relief chamber, thus avoiding possibility of too positive a restoring action, which might result in contacting the disc faces and scoring.

The next interesting centrifugal pump article, by Igor J. Karassik and Roy Carter, will appear in the April issue of INDUSTRY & POWER. It will deal with shafting and seals.

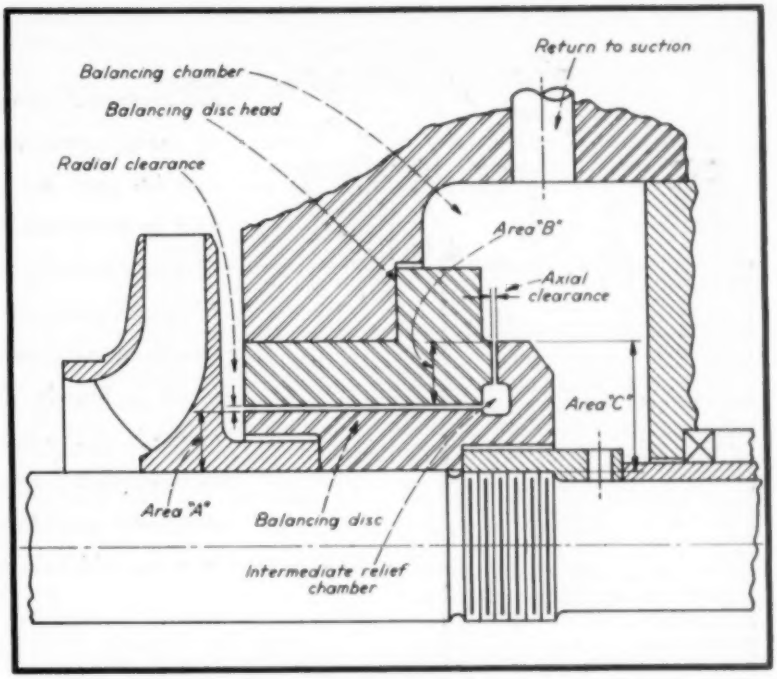
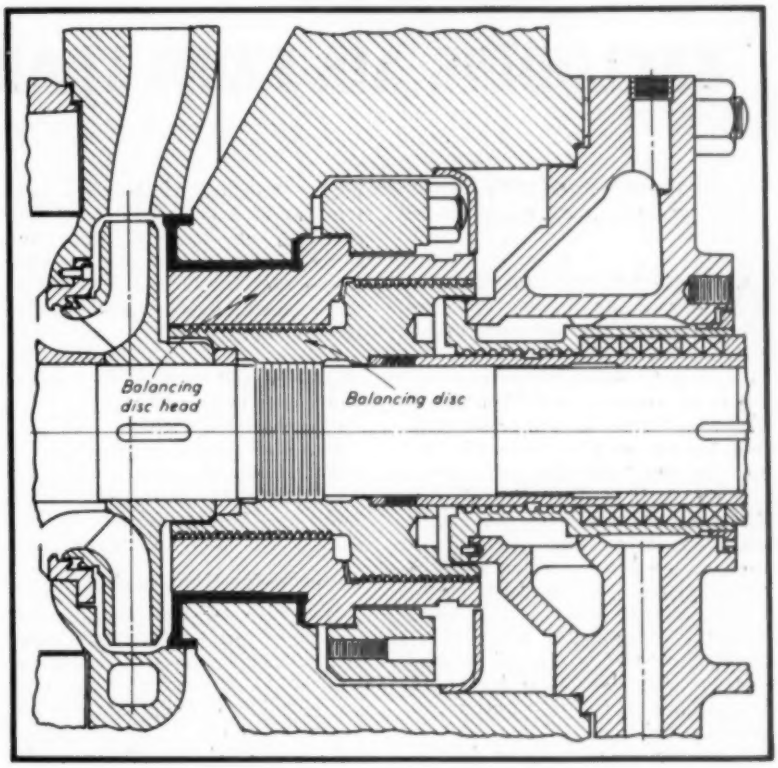


Fig. 3—In the combination disc and drum method of balancing axial thrust the rotating portion consists of a long cylindrical body. Radial clearance is constant regardless of disc position, while the axial clearance varies with the axial positioning of the pump rotor

Fig. 4—Modifications can be incorporated into the combination disc and drum method, as indicated below. This device consists of separating the drum into two halves, one precedes, the other follows the disc. This provides a cushioning at the intermediate relief chamber



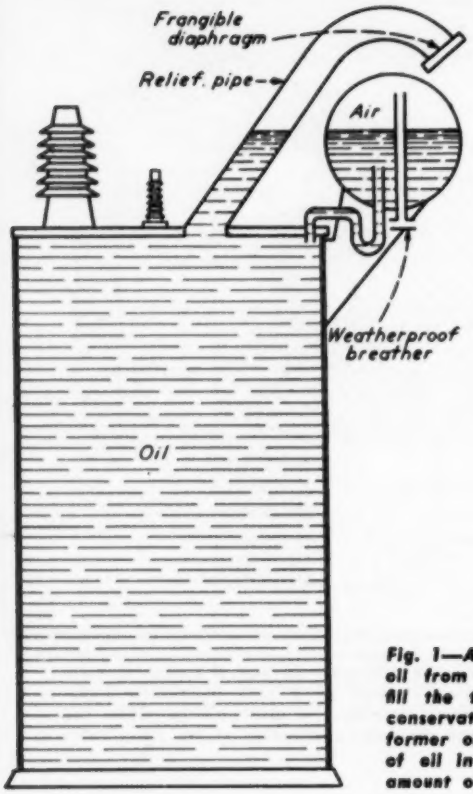


Fig. 1—An old but still common method of protecting oil from atmospheric deterioration is to completely fill the transformer tank and provide the auxiliary conservator unit. This allows expansion as the transformer oil heats, but has only a small, cool surface of oil in contact with the air. Space required and amount of oil used are disadvantages for this method

Oil-immersed power transformers are preferred in many applications, particularly when they can be used outdoors. In primary substations and in the increasingly common outdoor load center installations, cost is often a deciding factor. Continued ability of the oil immersed transformers to compete with newly developed types is largely due to improvements in the methods of protecting oil from the oxygen and moisture that formerly meant frequent replacement and reconditioning. Here are descriptions of many old and new methods commonly used

Modern Methods For

EXCLUDING AIR FROM TRANSFORMER OIL

FRANK E. REEVES
Electrical Engineer

AIR AND MOISTURE are enemies of transformer insulating oils. Oxygen in the air causes hydrocarbon oils to oxidize when heated due to loading of the transformer, resulting in formation of acids and sludge. The acids formed combine with moisture (which usually enters with the air) and cause corrosion.

Sludge is the result of continued oxidation of the oil, being formed by polymerization or condensation of the oxidation products in contact with the oil. If produced in appreciable quantities, sludge blocks the cooling ducts and abnormal heating results. The effect becomes cumulative if allowed to continue, as the subsequently higher oil temperatures accelerate formation of oxidation and sludge.

In addition to reducing or destroying the insulating qualities of oil, moisture has been known to cause short circuiting of windings when rust formed on the under side of the transformer tank cover and dropped in sheets across the submerged high voltage terminals.

The four principal schemes for excluding air and moisture from power transformer tanks are:

1. Conservator method
2. Automatic inert gas method
3. Gas-oil seal method
4. Hermetically sealed tank.

Power transformers are here defined as those with ratings above 500 kva.

Conservator Construction

The oldest effective but still quite common scheme, the conservator method, prevents the entrance of air or moisture to the main transformer tank by filling it completely with oil. A small cylinder (the conservator tank) is mounted above the main tank, Fig. 1. The smaller tank is partly filled with oil and is directly connected to the top of the transformer casing so that oil feeds to it by gravity. Air space above the oil in the conservator connects to atmosphere through a weatherproof "breather" or ventilator.

The breather usually consists of a vertical pipe running from the air space down through the bottom of the small tank, where it is open to the atmosphere through suitable screens to exclude insects. Although oil in the conservator is continually exposed to air at atmospheric pressure, it is relatively cool because it does not circulate by convection between the main tank and the conservator. Only a small amount transfers between the main and conservator tanks when the main body of oil expands or contracts due to temperature variations from load cycles or changes in ambient temperatures.

Since only the smaller, cool surface

of the oil is exposed to air, air in the conservator does not cause appreciable acidification and sludging. Moisture accumulates on the bottom of the conservator tank as water which may be drained off periodically through a valve on the underside. Water cannot enter the main transformer case because the connecting pipe terminates well above the bottom of the conservator tank as shown.

To prevent sudden pressure build-up (due to a short circuit in the transformer) from bursting the main tank, a frangible diaphragm is provided in the large diameter pressure relief pipe mounted on the top cover.

Disadvantages of this construction are (a) the additional space required by the conservator tank, and (b) additional oil required not only by the conservator but also to completely fill the main tank. The tank and relief pipe occupy valuable space needed for high voltage clearances, lightning arresters, spill gaps and the like.

EXAMPLE OF OIL PROTECTION METHODS AVAILABLE

Transformer ratings, kva	Manufacturer's standard	Types available at no increase in price
501 - 2500	Sealed tank	Gas-oil seal or conservator types
2501 - 10,000	Sealed tank	Gas-oil seal, conservator, or automatic gas seal types
10,000 and up	Automatic gas seal	Sealed tank or conservator types

Automatic Inert Gas Method

The scheme in which a cushion of relatively pure nitrogen is automatically maintained in the space above the oil in a transformer tank is shown in Fig. 2. Nitrogen in the space is maintained under slight pressure to prevent in-flow of air and moisture in event of leaks in the cover.

This construction requires continuous use of an ordinary high pressure nitrogen cylinder. Initial cylinder pressure is 2000 psi, but a reducing valve maintains a constant low pressure on the transformer side of the valve. It automatically admits nitrogen to the space above the oil when the transformer tank pressure falls below ½ psi, and closes the nitrogen supply when the pressure rises slightly above ½ psi.

The gage on the high pressure side is usually equipped with alarm contacts for warning when the nitrogen supply is low. The transformer gage is of the pressure-vacuum type and may be equipped to sound an alarm when pressure or vacuum is excessive.

After the transformer tank is first filled with oil to the proper level, the air and moisture are purged while nitrogen from the cylinder is being fed into the space above the oil. Thereafter, as long as the transformer tank remains pressure tight, the nitrogen cushion is maintained automatically. By preventing air and moisture from entering, oxidation, sludging, corrosion, and rusting are prevented.

Although this system is very effective, and widely used, it has the disadvantages of requiring periodic testing of the quality of the gas in the space above the oil, and also requiring a convenient source of cylinders of nitrogen. Although testing procedure is relatively simple, it does require some training and regular inspections by personnel trained and equipped for it. Dry nitrogen is required. In some localities, particularly foreign countries, even though nitrogen is available, it is not dry enough.

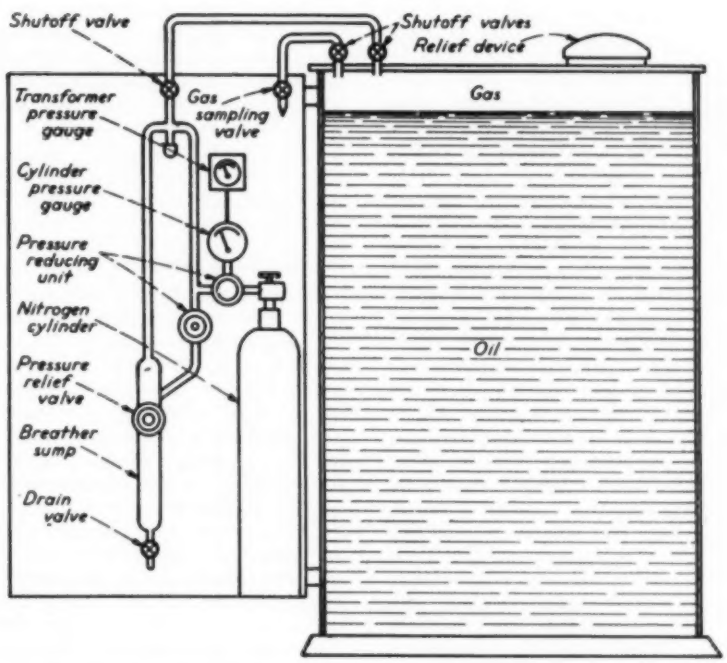


Fig. 2—The automatic inert gas (nitrogen) method protects the surface of the oil in the expansion space in the main tank with a blanket of non-oxidizing and moisture free gas. A positive pressure is maintained automatically by the extra equipment, at left, required for this method

Oil Sealed, Inert Gas Method

A scheme whereby nitrogen is maintained in the cushion space above the oil in transformer tanks, but which does not require the permanent connection of a nitrogen cylinder is shown in Fig. 3. A cylindrical expansion tank is mounted horizontally on the top of the transformer. A partition in the center of the tank separates the two halves.

The expansion tank is half filled with oil, and an opening in the bottom of the partition permits interchange of this oil between the two sections. Air can enter the upper part of one section (right half, Fig. 3) through a uni-directional breather mounted underneath. This section also has an upper vent so that air above the oil in this half of the tank is under atmospheric pressure.

Space above the oil in the other half of the expansion tank is connected to the area above the oil in the main transformer tank, both spaces to be filled with nitrogen. Initially, a nitrogen cylinder is connected to the gas sampling valve. After all air is purged from the two gas spaces, pressure is allowed to rise slightly and the bleed valve is closed. The nitrogen cylinder is then disconnected, and may be used elsewhere.

As oil in the transformer tank heats and cools due to load cycles, there is a slight change in oil level in the main

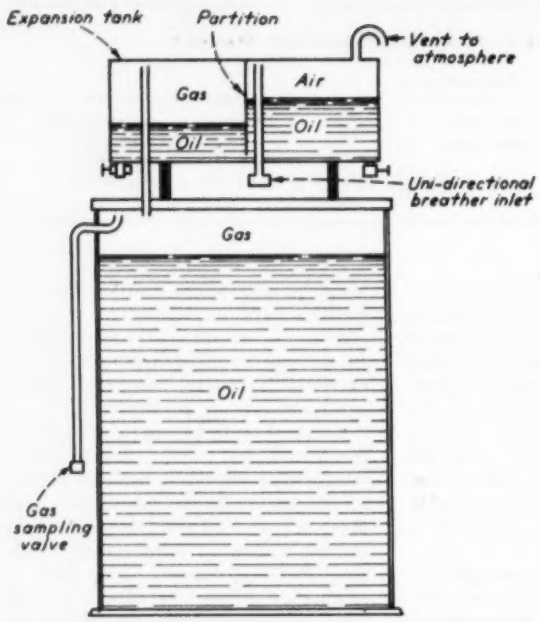


Fig. 3—As the transformer oil volume changes with temperature, the protective gas may flow to or from the expansion tank without appreciable change in the pressure in the oil sealed inert gas construction

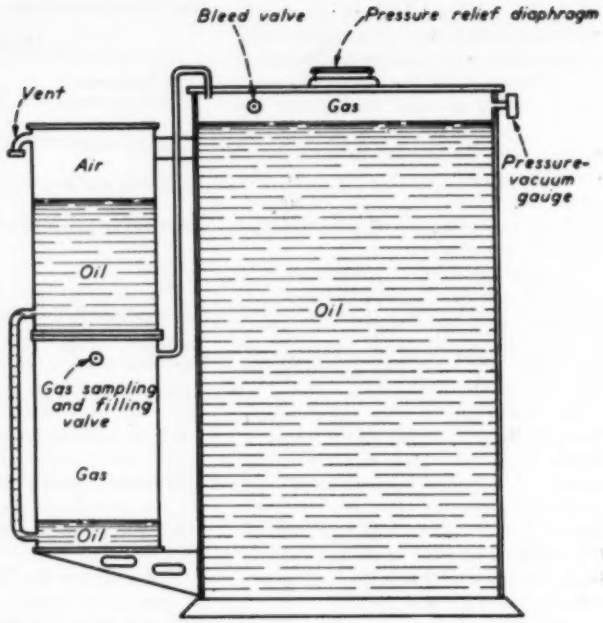


Fig. 4—The gas-oil seal method is like the one in Fig. 3 but has the expansion tank mounted on the side. In each case, seal oil only separates the gas and air and helps maintain pressure; does not interchange with cooling oil

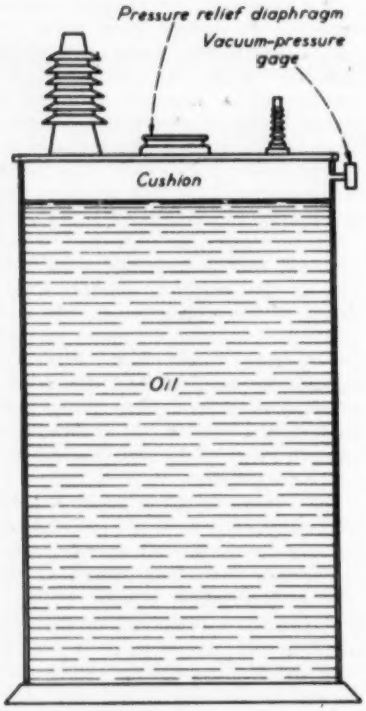


Fig. 5—In sealed constructions, tank and bushings are designed for pressure ranges from 10 psi down to negative values, or vacuum. The reliability of modern equipment makes difficulty of major repairs relatively unimportant

and expansion tanks, but there is no interchange of oil between them. Gas pressure is maintained by the difference in head between the oil in the right and left hand halves of the auxiliary tank, the right hand section having the higher level at all times.

The two-breather system shown on the right hand half of the expansion tank in Fig. 3 is not typical but does illustrate the extent to which designers will go to prevent contamination of the oil. Fresh air, aided by warmth from the transformer below, enters the lower vent, passes across the tank and out the upper vent.

Circulation of the air carries off moisture and helps prevent condensation, which, by contamination of the seal oil, might eventually introduce small quantities of moisture to the main tank. Similar results may be produced by other designs.

Purity of the gas is maintained by periodic tests as with the inert gas system, the nitrogen cylinder being connected when needed to restore the nitrogen seal.

Although this scheme requires less permanent equipment at the transformer, it has the same disadvantages as the inert gas system. Periodic tests by trained personnel are necessary, and a cylinder of dry nitrogen is needed.

Another similar scheme called "Gas-Oil Seal" construction is shown in Fig. 4. The main difference is in the location of the double tank which is again cylindrical, but consists of two separate tanks connected together by piping. However, the upper tank is open to atmosphere only through a weatherproof vent.

The space above the oil in the main transformer tank and in the lower auxiliary tank is purged and placed under slight nitrogen pressure by the use of a nitrogen cylinder in the same manner. The same advantages and disadvantages apply, although difference in tank location with respect to electrical connections may be pertinent in some installations.

Sealed Tank Construction

Originally available only in the small sized power transformers, sealed tank construction, Fig. 5, was recently also made available in 10,000 kva and larger sizes. The main transformer tank is hermetically sealed, and, while the air above the oil may be removed by using a nitrogen cylinder, such purging is not considered absolutely necessary.

There is such a small amount of air and moisture trapped above the oil that the oxygen and moisture are quickly absorbed by the oil and walls of the tank (by slight rusting). With the oxygen thus removed, the space above the oil becomes almost pure nitrogen, and oxidation and rusting ceases. The modern procedure of (a) shipping the tanked transformer dry,

with the tank filled with nitrogen, and (b) vacuum filling with oil to the proper level, permits little oxygen or moisture to enter at the time of installation.

During normal operation, pressure within the tank is permitted to attain 8 psi, and the vacuum ½ in. It has been found that under the normal cycle of no load to full load, and back to no load, these pressure conditions are not exceeded. However, under overload conditions, or when a short circuit occurs within the transformer, pressure damage might be possible.

A pressure relief device set slightly above 8 psi will then open to permit the exhaust of gas. To prevent damage by high vacuum, a vacuum relief device is also used, and opens when vacuum exceeds ½ in. These conditions are unusual, and, except in cases of serious trouble, not enough air will be admitted to cause appreciable oxidation, sludging or corrosion.

The pressure limits for sealed construction are among the design details that vary with different manufacturers and models. For example, in one instance, limits are given as 8 psi positive pressure to 8 psi vacuum. In another case, relief valves are set for 10 psi pressure and 20 in mercury (about 10 psi) vacuum.

For successful operation of this type of transformer construction, the tank must remain pressure and vacuum tight. They are usually completely welded, and it becomes necessary to burn or chip off either the bottom or top welds in order to remove the core from the tank should extensive repairs be necessary. However, welded transformer tanks are now in common use. A vacuum-pressure gage will indicate whether or not the tank leaks except during unusual conditions when there is neither pressure nor vacuum during changes from low to high, or from high to low temperatures. Alarms are usually provided for high pressure or vacuum beyond the specified limits.

There are many advantages of this type of construction. No auxiliary tank is needed, and only occasional inspection is necessary. This inspection consists only of reading the pressure-vacuum gage. As long as the gage shows either pressure or vacuum, it may be assumed that there is no oxygen or moisture in the transformer. No extra equipment is needed for maintaining the nitrogen seal, and training of personnel in testing procedures is unnecessary.

The only disadvantages are need for maintaining a tight tank, and for slightly special bushings which will withstand the somewhat higher pressure differences without leaking.

At the present, there is no saving in first cost of the sealed tank over the inert gas types, but it is anticipated that there will ultimately be a differential in favor of the former.

The table shows the present status of one manufacturer's practice in regard to the various types of construction. It reflects the trend toward sealed tank construction, and a definite change in the picture since 1950. It is anticipated that sealed tanks will be preferred for all sizes in the near future.

Continuous Purification

A relatively new device for continuous removal of oxidation products and moisture from oil or askarel is shown in Fig. 6. An auxiliary cylindrical tank is mounted on the transformer case and the oil circulates through it by convection. Impurities, sludge and moisture are removed from the oil as it passes through activated clay or aluminum oxide in the auxiliary tank.

Valves in the auxiliary tank connections permit closing them so that the tank may be readily removed for periodic renewal of the purifying agent. Laboratory tests indicate excellent results in maintaining low values of acidity, power factor and moisture content in the oil and askarel in transformers under test. This device may be used on almost any type of liquid-insulated transformer, including those previously discussed.

Portable oil purification units are also now available on the market.

Askarel Cooled Types

The advantages of transformers that are cooled and insulated with the non-inflammable synthetic liquids are generally well known. However, their higher cost generally limits their use to indoor installations where elimination of a fireproof vault may justify the extra expense.

Askarel types are generally of sealed construction so that most of the foregoing discussion does not apply to them. However, some of the characteristics pertinent to the subject may be interesting.

The synthetic liquids for transformers are heavier than water so that if condensation could occur, the water would rise to the surface. Since it would be at the hottest region of the liquid, it would tend to vaporize more readily than in oil cooled types in which it collects in the coolest portion. For the same reason, the top sample of askarel and the bottom sample of oil are most important for testing.

Sealed construction is therefore the most desirable for askarel insulated transformers. Fortunately, they are also most important in the smaller sizes used for load centers and the like which made early development of the sealed tanks easier.

Another difference which affects the cost and, in general, prevents interchangeability of oil and askarel is the tendency of the latter to dissolve or disintegrate many of the insulating materials used with oil.

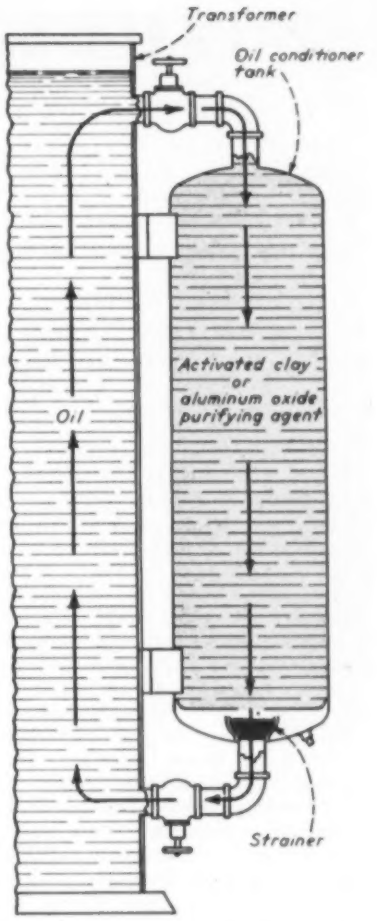


Fig. 6—Recent developments include oil purifiers, both portable and fixed. This type, which may be used with the methods previously described, continuously reconditions the oil while the transformer is operating. Automatic circulation is provided by convection

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PACKAGE BOILERS REDUCE STEAM COSTS

After Realty Associates, Inc. replaced obsolete boilers with modern package steam generators, plant fuel costs dropped from $44,000 per year to the amounts listed in Table I at the right

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Realty Associates, Inc.

TABLE 1 — PLANT OPERATING COSTS

Year	Fuel costs	Process steam sales	Net heating cost
1949	$15,406.70	$ 6,185.97	$9,220.73
1950	20,996.47	15,149.43	5,847.04
1951	21,798.95	14,042.02	7,756.93

INDUSTRY pays a tremendous price every year for boiler plant obsolescence. In many cases, the initial cost of new steam generators seems prohibitive, and all available capital is spent for production equipment. When improvements become imperative, however, the savings provided by new facilities often return the necessary investment within a very short time. To illustrate typical results that can be obtained, this article presents information on operating cost reductions achieved by Realty Associates, Inc. through a modernization program at Ann and Hope Mills in Lonsdale, R. I.

This plant was originally a textile mill of the type so familiar in the New England states. Built many years ago, it has large, multiple story, red brick buildings with wood structurals and floors. At present this space is subdivided and leased to small manufacturing companies thereby filling the void created when much of the textile industry relocated elsewhere.

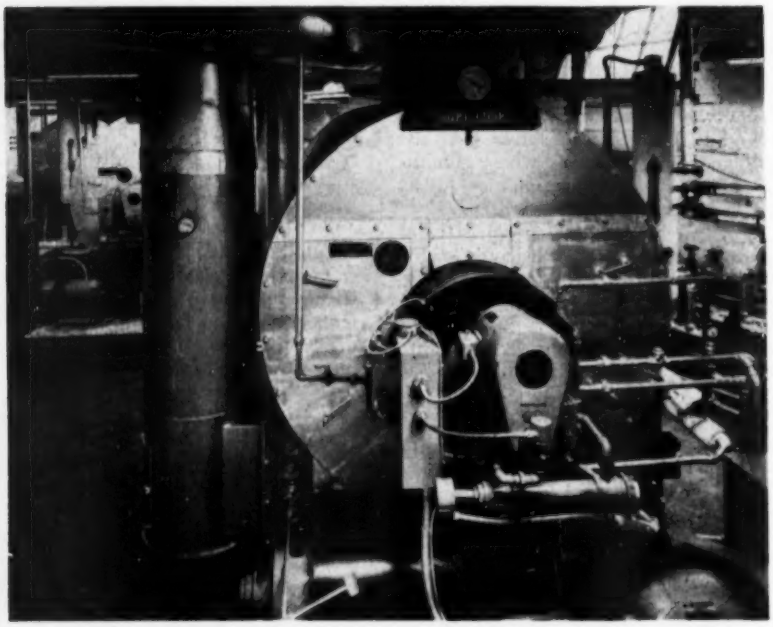
Fuel Cost With Old Plant

In 1947, Realty Associates, Inc. took over operation of the mill and soon found the condition of the existing boiler plant made it impossible to supply adequate heat and hot water for the tenants. Under these circumstances, companies requiring process steam could not be accommodated on the premises. In addition, annual coal costs averaged approximately $44,000 during 1947 and 1948, and the services of six firemen were required to maintain operations.

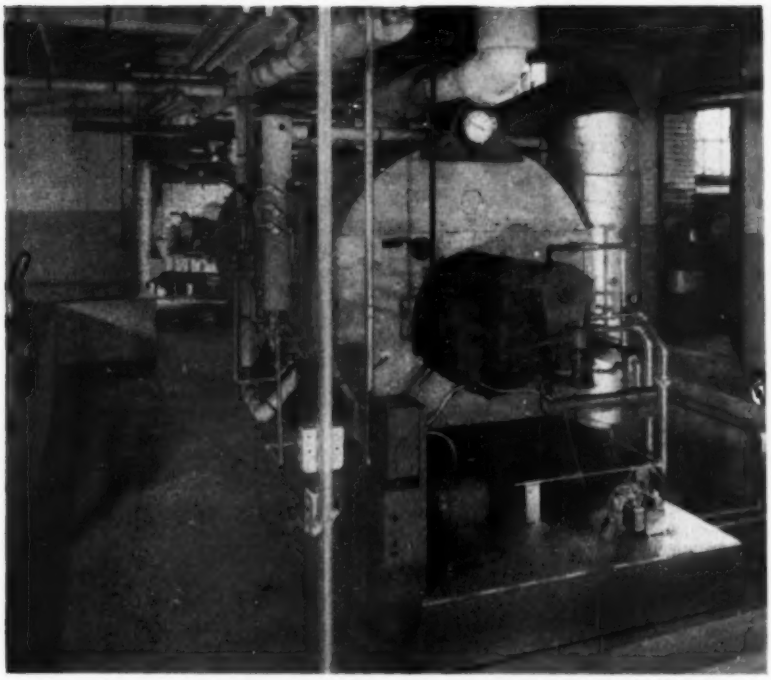
Since new equipment was an obvious necessity, three 150 hp firetube package steam generators were purchased and installed. Each of these units is designed for a pressure of 125 psig and, under normal conditions, 80 psig steam pressure is carried at the boiler outlets. At the time of purchase, it was anticipated that two units would carry the normal plant load and the third would provide for peak loads and possible expansion. However, during the winter of 1951, increased process steam and heating demands forced capacity operation of all three units. Therefore an additional 200 hp steam generator has been installed so the plant will again have facilities for peak loads or further expansion.

At the time of installation, the existing boiler house could not be disturbed and consequently the new units were placed in the basement of the main building. Since there was insufficient head room at this central location, it was necessary to lower the existing floor level by approximately 30 in. This was accomplished by digging below basement level and installing a 6 in. reinforced concrete floor on gravel fill to provide support for the boiler foundations. In addition, due to the wood structurals and floors, the boiler room ceiling had to be insulated and masonry fire walls constructed to isolate the area from the balance of the basement. With this arrangement, it was necessary to provide an opening through the side of the building for primary air supply and exhaust ducts to the steel stacks that were installed.

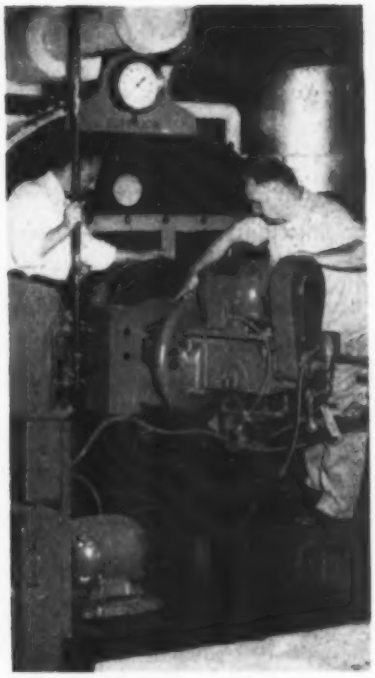
All of these steam generators are designed to burn No. 6 residual fuel oil, which is delivered by truck and stored in two 10,000 gal underground storage tanks. A third tank of 20,000 gal capacity will be installed shortly. Each tank has a suction heater using



"Shoe horn fit" aptly describes the squeezing of these three 150 hp steam generators into a boiler room 19 ft wide, 53 ft long, and only 12 ft high. Boilers lie at an angle of about 25 deg with the long wall, their overlap providing adequate space for access to each unit at both front and rear



Economical performance of the three 150 hp units installed in 1948 led to the addition in 1952 of the 200 hp steam generator shown in the foreground



Jim Furey, right, inspects burner on new 200 hp boiler. Fuel is No. 6 oil

steam as the heating medium, but normally sufficient oil is recirculated so that it is only necessary to use these heaters during severe winter weather.

Operating Cycle of New Plant

The operating cycle of the plant is completely automatic. Oil is pumped from the tanks continuously through a secondary heater in the boiler room which maintains a constant temperature of 165 F at the rotary cup burners. Oil pressure is maintained at 0.5 psig with approximately two-thirds of the total quantity circulated returning continuously to the tank. The oil is treated with oil additive for prevention of tank sludge accumulation. To date, no trouble has been experienced with the oil tanks and wiping the atomizing cups once on every eight hour shift provides good performance. Fireside inspections are normally conducted about every three months.

Steam leaving the boiler room is metered so that customers can be charged for the amounts their processes consume. Some of this steam is lost, and condensate returned during the summer averages only 30 per cent of the total feedwater. In the winter, most of the heating condensate is recovered and makeup is reduced to approximately 50 per cent of the total feed. During all seasons, condensate flows to a receiver which is equipped with a float control valve to modulate makeup water flow and maintain constant water level.

Feedwater leaving the receiver is pumped to the boilers by motor driven feed pumps. There is one pump per boiler and an additional spare pump can be used for any of the units. Feedwater treatment consists of internal phosphate and soda ash feeds. Water analyses to determine phosphate, alkalinity, and sulfate concentrations are conducted once daily to maintain feedwater quality within established limits. With this method of operation, waterside inspections of the units are required only once a year.

After the installation was completed, the obsolete equipment was removed from the existing boiler house and that space is now occupied by another industrial tenant. In all, industrial companies occupy 465,000 sq ft of floor space, and the package generators supply all necessary heat, hot water and process steam needs. In addition, the boilers supply steam for the plant fire pump when necessary.

Results achieved with this installation are summarized in Table No. 1 which indicates financial details of the first three years of operation with the package steam generators. It should be noted that fuel costs are considerably less than half of those experienced with the original plant, especially in view of the fact that the plant load is now much higher. Cost of supervision has been substantially reduced; for the six men (two each on three shifts) required in the original coal fired boiler room, are now released for other maintenance work about the plant. The added advantage of selling process steam still further reduces the net heating cost, and it is apparent the investment already has been retired.

PRINCIPAL EQUIPMENT AND SUPPLIERS

Steam generators	Superior Combustion Industries, Inc.
Boiler feed pumps	Roy E. Roth Co.
Boiler feed pump motors	Westinghouse Electric Corp.
Steam flow meters	Builders Iron Foundry
Non return and stop valves	The Lunkenheimer Co.
Blowdown valves	Everlasting Valve Co.
Steam and water valves	The Lunkenheimer Co.
Insulation	Johns-Manville
Fuel oil	Gulf Oil Corp.

STEAM PIPING . . .

• • • • can be economical or costly depending on the care exercised when designing and maintaining distribution systems. In this article, the author presents basic recommendations that can be used to obtain efficient performance on new installations or to improve existing systems

LEO WALTER
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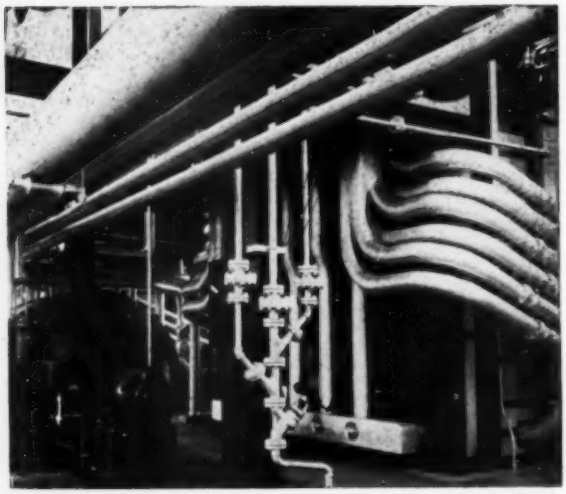


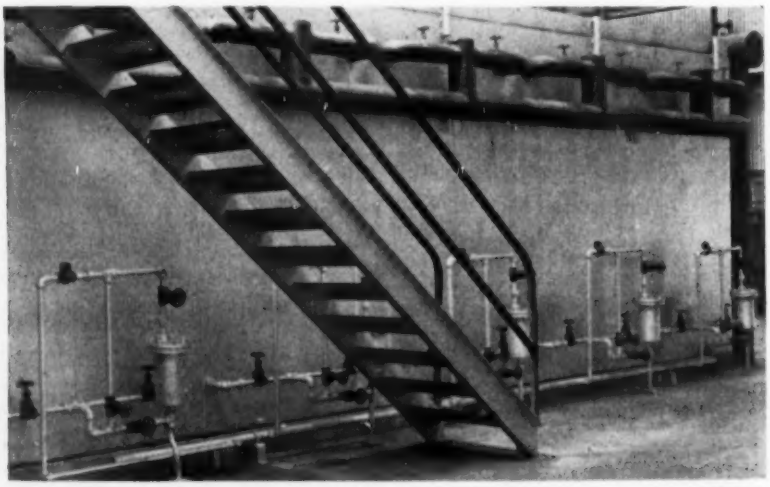
In addition to providing support, pipe hangers with rollers permit lateral movement of lines between expansion joints

EFFICIENT PIPING SYSTEMS have an important influence on the operating economy of any plant. Many industries recognize this fact and make every effort to properly plan, correctly install and adequately maintain their piping systems. There are, however, other plants where poor layouts are in use that are detrimental to efficiency. For example, haphazard piping extensions, which ultimately cause an overload condition, may have been added over an extended period of time. In other instances, piping maintenance either is neglected or only performed when something has failed. Such situations will be reflected by high maintenance costs and reduced or irregular output. Of course, all of the possible piping system deficiencies may not be present in any single plant. But where multiple weaknesses do exist, correcting even one poor practice will result in improved operation. Therefore, the following recommendations are flexible, since no hard and fast rulings can be given for the individual circumstances of every plant. First installation cost plays its part and often limits achievements.

Design Factors

Piping system design depends principally on the specific application, but pressure, distance, volume, possibility of corrosion and fluid characteristics are also important considerations. In some cases, the piping may be confined to a small area while other installations, such as district heating systems, may have distribution lines extending over many square miles. Small or large volumes of various fluids can be conveyed under high or low pressure through different sizes and types of pipe. All of these factors must be evaluated when designing new systems or modifying existing facilities. While the suggestions contained in this article are confined to steam distribution, the principles are of a general nature and can be applied to any type of piping system.

During the war, most plants were forced to extend their piping systems to meet emergency production demands. Often, overload conditions with resultant excessive velocities and high pressure drops developed. To correct this condition, fluid velocities throughout the entire system should be determined and compared with accepted standards. Portable steam meters are valuable for measuring flow rates. Then the correct size pipe can be established in accordance with the actual load. If the line is found to be oversize, it should be replaced with smaller pipe to eliminate unnecessary radiation losses.



Whenever possible, steam specialties should be installed in a by-pass with shutoff valves at both inlet and outlet to simplify repairs or replacement

Sizing Supply Lines

When installing process equipment, it must be remembered that the inlet connections do not indicate the correct pipe size for all steam conditions. These connections for steam supply on jacketed vessels, dryers, presses, coils and other process equipment usually are standardized by the manufacturer to be big enough for the lowest possible steam pressure that is allowable for the incorporated heating surface. Thus, a 2 in. diam connection on a piece of plant equipment may have

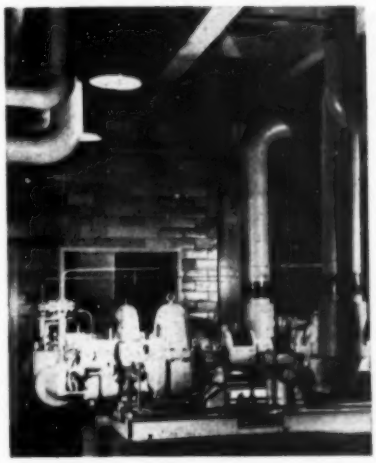
Both steam supply mains and condensate return lines for this overhead unit heater installation are equipped with pipe loops to take care of expansion

been calculated for 25 psig steam pressure. If in practice 80 psig pressure is used and a 2 in. supply pipe is installed, working conditions become quite different from those the designer of the equipment had in mind. The apparatus may stand up to a maximum pressure of 80 psig, but the 2 in. steam supply pipe would be oversized. In such cases, the correct pipe size for actual conditions must be determined by calculations.

New piping layouts and major extensions in existing plants usually are designed by experts. More often than not, however, little care is exercised when connecting additional plant equipment, and this may cause trouble as any alterations can affect over-all economy. For example, steam pipes may be left in place, with just a leaky shutoff valve at the end that contributes to heat losses, after a piece of equipment has been scrapped. Or the number of steam consuming machines connected to the original steam mains may be doubled with consequent higher pressure loss and steam starvation.

Locating Steam Specialties

All auxiliary steam specialties, such as reducing valves, control valves, traps, strainers and gages, should be located where their performance can be checked easily. Inaccessible equipment is difficult to service, or even to operate in case of emergency, and poor positioning of valves frequently causes trouble. This point is of major importance and must be given careful consideration during the reorganization of any piping system. For example, there is no necessity for using ladders to reach equipment when chain wheels or extension stems can be substituted. A



Color schemes or identification bands will facilitate maintenance procedures

further aid to preventive maintenance of piping in general is the use of a color scheme for identification.

Complete layout drawings are essential to the efficient operation and maintenance of any piping system. When alterations or additions are made, details of the work should be incorporated on the drawings to assure that the records are up to date at all times. Many well organized plants also keep card index files or log books which contain full information on all component parts. This information may include sources of supply, dates of purchase, records of routine maintenance and data on repairs or replacements.

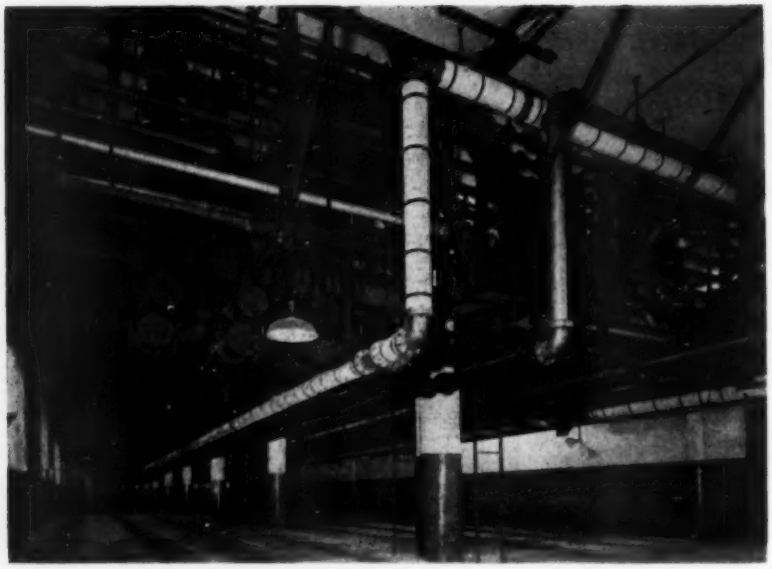
Whenever a replacement part is required, the performance record of that particular item should be examined carefully by the engineers. If a certain type of equipment has caused excessive trouble or failed in a short time, it might be advisable to specify something better even though the replacement may cost more. Instances of "grading-up" are numerous. Perhaps a new valve should have a stainless steel renewable seat instead of the brass seat previously used. For other applications, the streamlined seatless type may help minimize pressure loss and wire-drawing. Thus, selection of replacement parts should be based both on service conditions and records of past performance.

Worn-out parts or leaks in piping are always costly and frequently cause unnecessary spoilage of manufactured goods. In some cases, contamination and dilution, not uncommon in poorly equipped plants, may disrupt process operations. Such situations generally result from faulty installation methods or negligent maintenance. Pipe ruptures or valve failures are a big nuisance and increase maintenance overhead considerably. They not only endanger lives and cause damage to equipment, but may result in shutdowns in part or all of the plant.

Periodic Surveys

The importance of conducting a very detailed survey of the whole piping installation at least once a year and of keeping complete records can not be overemphasized. These procedures soon reveal weaknesses and contribute greatly to safe continuous operation. Of course, if major modifications of manufacturing methods occur, involving changes in pressure, temperature or fluid volumes, additional surveys must be made. Then the influence of increased load on pipe strain, expansion, supports, vibration and condensate drainage should be studied.

Construction photograph shows typical welded steam header and branch mains



This intricate layout is part of a system which contains 50 miles of steam, water and process solution piping. Overhead walks provide access to valves

Piping systems should be sectionalized as the lack of isolating valves can cause great difficulties in plant operation. Any individual section of piping should be planned so it can be cut out at will. Reducing valves, control valves, steam traps and similar equipment always should be installed in a by-pass with shutoff valves at both inlet and outlet to permit servicing or repair without stopping production.

Condensate and Air Removal

Correct trapping and air venting of steam pipes is of the utmost importance. The formation of pockets of water or of air in a steam pipe reduces flow rate and retards heat transfer, with consequent delays in heating. Very efficient methods have been worked out for using individual steam traps as opposed to group trapping, and for fitting automatic air vents to pipes and equipment. Usually, the air vents are located at the highest point of liquids, but the venting point of steam depends on working conditions although it generally is at the end of the line farthest from the inlet.

Separators

Condensate in the form of small droplets is always present in steam, and should be removed to keep the steam "dry." Drops of water have a greater density than steam, and this physical quality can be used to precipitate the moisture. Some separators are designed to reduce the speed of steam in a vessel, which causes the larger droplets to fall out by gravity. Other types employ a series of rapid changes in the direction of flow or centrifugal force to drive out the moisture. In most units, condensate collects at the lowest point of the separating vessel and can be drained by a suitable steam trap. The installation of oil separators in condensate recovery lines is extremely important, particularly if the condensate has been contaminated and is to be used again.

All piping systems must have tight connections between the pipe and fittings or other components. Any joint leakage is a source of waste and trouble, and should not be tolerated. In general, steam systems utilize threaded, flanged or welded connections depending on service conditions, although sometimes brazed or soldered joints are used for brass pipe and copper tubes respectively. Flared or compression fittings also can be employed for copper or plastic tubing.

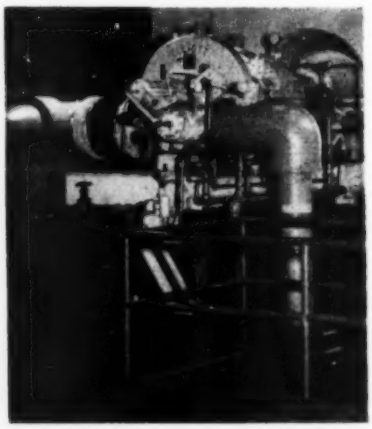
Threaded connections probably are used most widely for small size pipe and low pressure applications. Usually, mains above 3 or 4 in. diam have flanged joints because assembly or dismantling is simplified. Welded ends are becoming more popular for all sizes of pipe, particularly where the application involves high pressures or temperatures, and this type system should be considered when modernizing existing facilities. In any case, misalignment must be avoided as it causes excessive strain at the joints and support points.

Provisions for Expansion

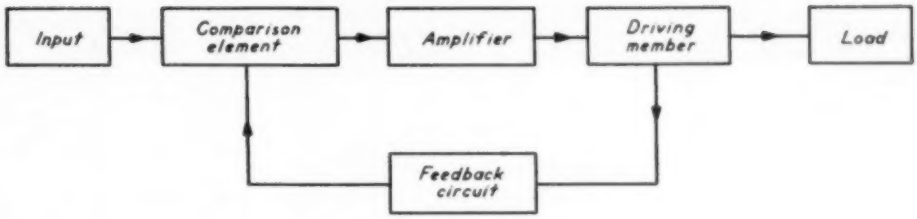
Every efficient piping layout must have some provision for the expansion and contraction caused by heating and cooling cycles. Typical methods for satisfying this essential requirement include the use of pipe bends or loops, and various types of fabricated expansion joints. The exact selection of specific equipment will depend on the system details and space limitations. Maintenance is also a consideration, and whenever possible, fabricated expansion joints should be designed for servicing at full pressure.

In many cases, machinery will cause pulsation in pipelines. This can be eliminated by using vibration inset pieces or flexible connections at the machines. If vibration is caused by water hammer, the source of trouble should be located and corrected. Receiver-separators or steam traps for better condensate drainage usually will alleviate water hammer. Air chambers also can be used, but continuous maintenance of the air cushion is required to secure the desired results.

Individual thermostatic traps are used to drain condensate from these presses



Flexible connections are used for many applications where space is restricted



Operating Characteristics of DRIVES FOR REGULATED SYSTEMS

Among the factors affecting stability and response of regulated speed drives and positioning type of servos are inertia of moving parts and slope of the speed-torque curve, or its inverse counterpart, damping. Derived from them, the mechanical time constant indicates ability to hold speed constant. Using only the drive as an example, the article shows how to calculate its value for both drive and load and discusses its relation to other factors, such as amplification and phase shift in feedback and error signals, in servo design

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EXTENSIVE APPLICATION of high accuracy, automatic control systems make it important that each component be selected to best meet the requirement of the application. In a particular case, requirements may vary depending upon the viewpoint. For instance, servo system design usually is concerned mainly in the required accuracy and adequate speed of response and will favor components which have the best control system characteristics.

On the other hand, machine design may be concerned with factors such as size, shape, weight, and temperature rise. Finally, price may have considerable influence in the selection of components. In a typical case, final choice must be a compromise.

This paper considers one important element, the output driving member, of that class of feedback control systems in which some aspect of motion is regulated. The most significant characteristic of each of the commonly used types of driving members is discussed from the viewpoint of servo design. A comparison may indicate some of the penalties paid in performance if other criteria are used in selecting the driving member.

Types of driving members considered are (a) shunt-wound d-c motors, both with and without field control, (b) two phase a-c motors, (c) hydraulic motors supplied from variable delivery, positive displacement pumps, (d) eddy-current electric couplings and (e) magnetic particle or magnetic fluid clutches. All of these devices in combination with their associated power sources are characterized by their ability to deliver a controllable amount of mechanical power.

Before proceeding with a detailed discussion of these devices, a few general remarks concerning feedback control systems and the significant drive member characteristic are in order.

Feedback Control Systems

Basic elements of a typical feedback control system are shown in the block diagram at the top of the page. As mentioned previously, only systems in which the controlled quantity is some aspect of motion are considered here. This limits the discussion to systems which regulate position, speed, or acceleration, as contrasted with systems where voltage, current, temperature, pressure, fluid flow, or any other quantity is automatically controlled.

In the diagram, the quantity to be controlled is measured by a suitable device, and the signal fed back to a comparison element where it is matched against an input signal (not to be confused with power input, which may be mechanical). The difference between these two is called the error signal, which is amplified sufficiently to control the power required by the driving member.

By increasing the amplification

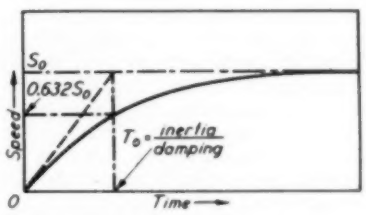


Fig. 1—With the input power suddenly applied, speed response of drive and load is exponential. Time constant, or the time required to reach 0.632 full speed, may be found by other methods

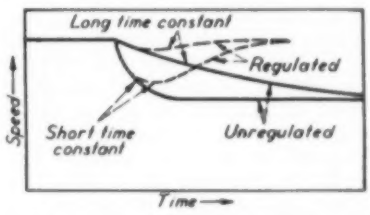


Fig. 2—Low time constant allows rapid speed drop and rapid recovery but with greater variation for suddenly applied load. However, at constant load torque, response to new speed setting is faster

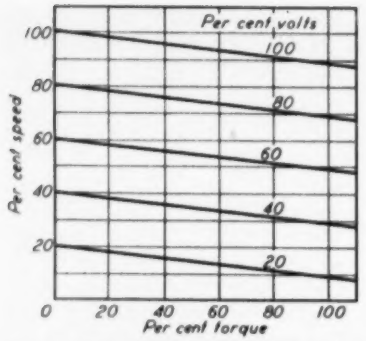


Fig. 3—The speed-torque curves of a d-c motor with armature voltage control and constant field are used in text for calculating the damping coefficient and, from it, mechanical time factor

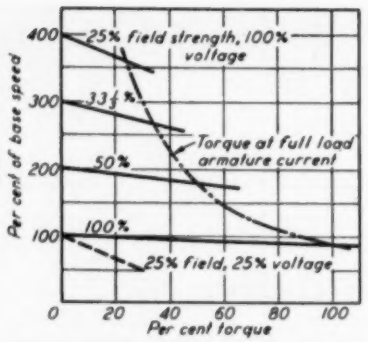


Fig. 4—Curves for a d-c motor under field control vary in slope, producing variable damping coefficient and time factor which is not desirable from the standpoint of control system design

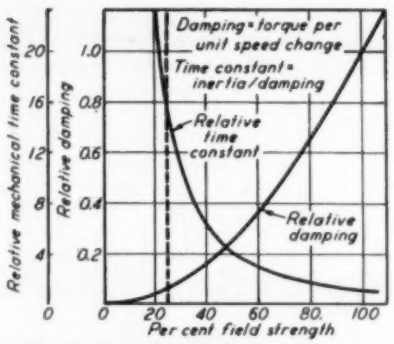


Fig. 5—The curves illustrate effect of varying field strength on damping and on the mechanical time constant in a d-c motor as a result of changes in the speed-torque characteristic curves

factor, the error signal can be very small compared to the input or feedback, and the feedback signal made as nearly equal to the input as desired. The input thus becomes a reference quantity and may be used to adjust magnitude of the controlled variable. The control system functions to keep the error signal near zero at all times, and effect of disturbances on the value of the controlled quantity is greatly reduced.

Control Stability

When designing a feedback control system, the problem is to provide accurate regulation of the controlled quantity and rapid recovery following any disturbance, with a minimum of oscillation about the regulated value. The two factors which determine stability of a system are amplification around the closed loop, and phase displacement between a signal introduced at one point and the correction signal which returns to that point from around the loop.

If under some condition of operation, phase displacement equals 180 deg, and if at the same time the amplification exceeds unity, the feedback signal will add to the input signal rather than subtract from it. The feedback then tends to increase without limit and the system is unstable.

Stability can be assured by reducing either system amplification or the phase shift. If a specified accuracy requirement is to be met, amplification usually cannot be reduced below a certain minimum. Consequently, the problem of providing stability generally becomes one of limiting the phase shift through the system.

Cause of Phase Shift

Phase shift around the closed feedback loop is the accumulated effect of time constants of various elements of the system. These time delays are associated with inductances of electromagnetic winding, inertias of moving parts, capacitance in filter circuits within the feedback loop, stiffness of spring members, compressibility of fluids, or any other factors which prevent instantaneous response of any system component to an input signal.

Mechanical Time Constant

The most important characteristic of the driving element in servo design is commonly referred to as the mechanical time constant. This is a measure of the *rate of response* of the output shaft to a sudden application of input power.

A typical response is illustrated in Fig. 1. Following sudden application of input power, the speed of an ideal drive member approaches its final steady-state value exponentially. The mechanical time constant is defined as the time required to reach 63 per cent of this final value. It can also be defined as the time required to reach the final value if the initial rate of rise, dotted line, were constant throughout the entire change.

In terms of operating characteristics of the driving element, the mechanical time constant is also defined as ratio of the moment of inertia of the drive member to its damping coefficient. The inertia may be considered as the torque required per unit acceleration, and the damping coefficient as the torque change per unit speed change (as with change in load torque divided by resulting speed drop at a given point on the curve). The damping coefficient is related to the speed-torque curves as described later.

To achieve optimum system performance, the mechanical time constant should generally be as small as possible. This is particularly true in positioning servos and in speed regulators where output speed must respond quickly to an input change. Also, the mechanical time constant should vary as little as possible over the operating range of the drive member.

There is one important case, however, where a long mechanical time constant is advantageous. This is true where output of a speed regulated system must remain constant when load torque suddenly changes. Fig. 2, typical of a d-c motor drive, illustrates this case. A simplified explanation of the effect is:

If the motor is unregulated, its speed will drop exponentially to a new steady state value when the load torque is suddenly increased. If the time constant of the motor is increased by addition of a flywheel, for example, speed will fall to the same value when the load is increased, but at a slower exponential rate. This is illustrated by the solid curves of Fig. 2.

Now suppose that a speed regulator is applied to the motor. Because of time delays in the amplifier portions of the control system, the appearance of a corrective voltage at the terminals of the motor will be delayed. During this time delay interval, speed of the motor with the short time constant will have dropped more than the speed of the motor with the flywheel. Therefore, the longer mechanical time constant permits the regulator to perform its corrective action before the speed has dropped an excessive amount. Thus an increase in mechanical time constant can bring about smaller speed error when a regulated motor is subjected to sudden loads.

D-C Motor, Constant Field

The mechanical time constant was defined as ratio of moment of inertia to the damping coefficient, the latter quantity being torque per unit

speed change. This implies that the damping coefficient can be determined from the speed-torque curves of the drive element, and such is the case.

Speed-torque curves of a typical d-c motor with constant field and with armature voltage control are shown in Fig. 3. In a typical control system, the motor will be supplied from an adjustable voltage generator whose field current is proportional to the error signal. The curve for 100 per cent voltage indicates that a change in torque from zero to full load causes a speed change equal to 10 per cent of the rated speed.

By way of illustration, assume that the motor of Fig. 3 is rated, for example, at 5 hp, 1750 rpm. Its full load torque is 15 ft-lb, and speed drop corresponding to full load torque is 175 rpm or 18.3 radians per sec. The damping coefficient, therefore, is 15/18.3 = 0.83 ft-lb per radian per sec. The inertia (torque required per unit acceleration) of the armature of a motor of this rating is approximately 0.023 slugs, or 0.023/0.83 = 0.028 sec for the mechanical time constant of the motor.

Therefore, motor damping for a particular operating condition is inversely proportional, and time constant directly proportional, to slope in the speed-torque curve. The steeper the slope, the lower is the damping and the greater the time constant. For a d-c motor with constant field strength, speed-torque curves for different armature voltages are parallel as shown in Fig. 3. Consequently, mechanical time constant of the motor does not vary over the operating range. As mentioned previously, this is a very desirable feature from the control system design standpoint.

At this point, it should be noted that speed drop shown in Fig. 3 and used in computing mechanical time constant of a d-c motor is generally only the drop attributable to the armature circuit resistance. Effect of armature reaction on the motor field is neglected. This is justified because any change in motor field strength due to armature current is retarded by the time delay of the motor field circuit. Furthermore, response time of a well designed regulator system is usually short compared to this field delay. Any transient variation in armature current will, in general, have died out before the field strength can change enough to affect damping appreciably.

D-C Motor, Adjustable Field

Solid curves in Fig. 4 represent the speed-torque characteristics of a d-c motor with rated armature voltage when speed variation is effected by field control. In a control system, either motor field current or armature voltage may be under the control of the error signal. The latter arrangement is more common and preferable. In this case, the field strength adjustment is an independent control used to increase the speed range.

As the field is weakened, speed increases in inverse proportion. Armature circuit IR drop corresponding to full load current is a fixed percentage of the applied voltage, making the corresponding speed drop a fixed percentage of the operating speed. Actual speed drop in radians per second consequently increases inversely as the field strength.

Furthermore, because of reduced field strength, torque corresponding to full load current is reduced proportionately. Consequently, the damping coefficient varies as the square, and the mechanical time constant inversely as the square, of the field strength. If at some reduced value of field strength, the speed is varied by means of armature voltage control, the speed-torque curves are parallel but they all have the increased slope corresponding to the lower field strength. This is illustrated in Fig. 4 by the curves for the 25 per cent field, 100 per cent voltage condition, and the 25 per cent field, 25 per cent voltage condition. Points along the dash-dot curve represent constant horsepower limits of operation for the motor.

The square law variation of damping with field strength is shown in Fig. 5. This figure also shows the inverse square law relationship between the mechanical time constant and field strength. If motor speed is varied by field control over what is usually considered as the maximum practical range of four to one, the mechanical time constant varies over a sixteen to one range. For optimum feedback control system performance, therefore, range of field control should usually be kept as small as possible.

Two Phase A-C Motor

Two phase a-c motors are extensively used as drive members in feedback control systems, particularly in sub-fractional horsepower sizes in instrument and computer drives. In these applications one of the two windings is supplied with a fixed a-c voltage from a reference source, the other winding with a variable control voltage whose phase is shifted 90 deg from that of the reference voltage. The control voltage is usually obtained from an electronic amplifier and is generally the amplified error voltage.

A-c motors intended for servo applications are generally specially designed with very high rotor resistance compared to conventional a-c motors. This gives them essentially straight speed-torque curves that avoid the reverse curvatures characteristic for motors of conventional design. These reverse curvatures represent negative damping which is detrimental to control system stability.

Because of their high rotor resistance, a-c servomotors are relatively inefficient in the usual operating ranges of speed and torque. This is one reason they are seldom used in sizes larger than the low fractional horsepower ratings. Another reason is that there are no very satisfactory sources of controlled a-c voltage with adequate power handling capacity.

The speed-torque curves of a typical two phase servomotor are shown in Fig. 6. The usual operating range is from zero to 60 or 70 per cent of synchronous speed. There is considerable variation in slope of the speed-torque curves. Comparatively steep slope indicates relatively low damp-

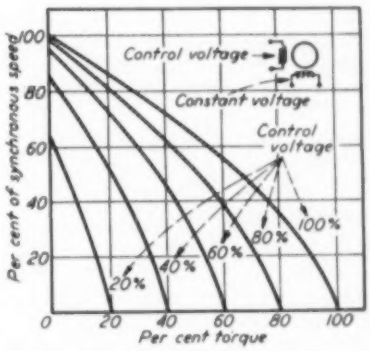


Fig. 6—Speed-torque characteristics of a two phase servomotor are steep, resulting in a low damping, or ability to resist load changes or accelerate to new values. However, with very low inertia rotors, time constant is small

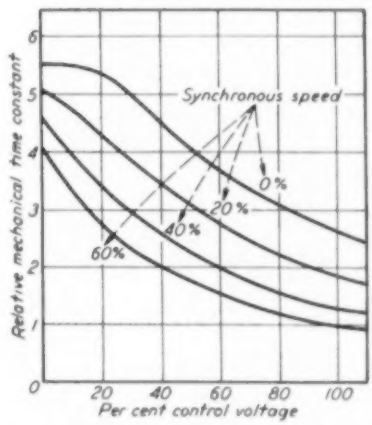


Fig. 7—The mechanical time constant of a two phase servomotor varies both with speed and with control voltage

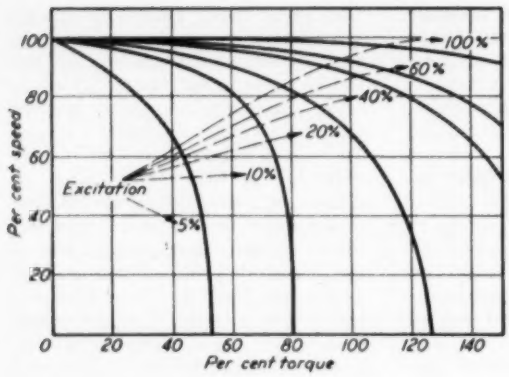


Fig. 8 — Speed-torque curves of eddy current couplings vary widely and give a high time constant at low speed values because damping approaches zero. In this, as in some other equipment, however, the low control power may permit the forcing of the changes required for restoring or corrective action and thereby compensate for slow response

ing, tending to cause high mechanical time constants.

However, a-c servomotors are usually designed to have very low inertia. In some designs, the rotor consists only of a thin cylinder of aluminum or copper, rotor core iron being stationary. Consequently, in spite of the relatively high damping, the mechanical time constant can be very small. Motors with a minimum value of time constant of the order of 0.01 sec are common. Fig. 7 shows that the range of variation of mechanical time constant with operating conditions of the typical motor of Fig. 6 is of the order of six to one.

Eddy Current Coupling

The variable speed, eddy current electric coupling is sometimes used in feedback control systems. This device consists of two members, one of which is driven by a constant speed motor while the other, the output member, is connected to the load. One of the members consists of an electromagnetic field structure energized by a direct current which, in regulator applications, is made proportional to the error signal.

When there is relative motion between the two members and the field is energized, eddy currents are induced in the other member. These react with the magnetic field in such a manner as to develop torque at the shaft of the output member. Magnitude of the torque developed depends on field strength and the difference in speed or slip between the two members.*

Typical speed-torque curves are shown in Fig. 8. Slope of the curves is seen to vary between extremely wide limits in the operating range of the unit. Damping, in fact, approaches zero at low values of excitation and low speeds (small torque change divided by large speed change). In this range, therefore, the mechanical time constant approaches infinity, and consequently, the eddy current coupling must be applied with caution in feedback control systems, particularly when these are of the positioning type of servo. However, minimum value of the time constant of the eddy current coupling can be very low, or 0.01 to 0.02 sec.

Another limitation of this device is that it is not reversible. Regardless of the polarity of the control current in the field winding, the output member of the coupling can rotate only in the same direction as the constant speed member. See the following discussion.

*For more detail as an adjustable speed drive, see "Eddy Current Couplings for Speed Control and Clutching", INDUSTRY AND POWER, December, 1952.

Magnetic Particle Clutch

A relatively new device for controlling mechanical power transmission is the magnetic particle clutch. Like the eddy current coupling, this device consists of two independently rotating members, one driven at constant speed by a motor and the other connected to the load. The small gap between the two elements is filled with small magnetic particles. In some designs, the particles are suspended in oil and the clutch is called a magnetic fluid clutch.

In a magnetic field, the particles tend to bind the two members of the clutch together. Source of magnetic flux is a coil which may be a part of one of the rotating elements, or which may be stationary. The coil current, in servo applications, is made proportional to the error signal.

The speed-torque curves of a representative magnetic particle clutch are shown in Fig. 9. Maximum torque that the clutch can transmit depends on shear resistance of the magnetic particle medium and varies as the square of the field flux. If load torque exceeds shear torque, the clutch will slip; and if load torque is less than shear torque, the output element will run at the same speed as the driven element.

Slope of the speed-torque curves in the servo operating range below 100 per cent speed is quite high, damping approaching zero at low control currents. For a typical clutch, the mechanical time constant with 100 per cent excitation may be of the order of 5 sec. The value approaches infinity as control current approaches zero. Since the control of torque is essentially independent of speed in this device, care must be exercised in its application to positioning servos to avoid instability.

The magnetic particle clutch is similar to the eddy current coupling in that it is not reversible. It can exert torque in only one direction. This disadvantage is overcome for feedback control system applications by incorporating in a single assembly two oppositely rotating clutches working on a common output shaft.

Hydraulic Drive

A very common type of drive in automatic control applications is the hydraulic motor or hydraulic piston and cylinder combination supplied from a variable delivery, positive displacement pump. This type of drive has several features which recommend it for servo applications. It can be faster in response than any of the other types of drive discussed above, and if high pressures are used, the horsepower output per unit of size is high.

The speed-torque curves of a rotary hydraulic motor are qualitatively very similar to those of the d-c motor with constant field strength, Fig. 3. The drop in the speed-torque curves is due mainly to the leakage past the pistons or vanes of the motor.

Since the curves are straight and parallel, damping coefficient is con-

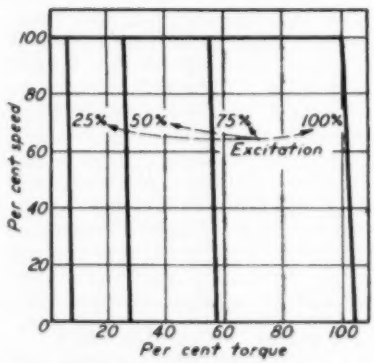


Fig. 9—Characteristic of a friction or of a magnetic particle clutch drops sharply as shear strength of the bond is exceeded. Furthermore, accelerating force cannot be greater than the bond

stant over the operating range. Value of the damping factor is of the same order of magnitude as that of a d-c motor of comparable rating. But because moment of inertia of rotating parts of the hydraulic motor is usually much smaller than for the equivalent d-c motor, the mechanical time constant can be of the order of one-tenth that of the d-c machine.

The time constant of a piston and cylinder type of output driving member can be even lower than that of a rotary hydraulic motor, since it may have lower inertia depending upon the dimensions, and possibly lower leakage because of better seals. Hydraulic drives are recommended for feedback control systems where high power output from a small space and extremely rapid response are required.

Comparison of Drives

The mechanical time constants of the six types of drives discussed above are listed in Table 1. These data, with the exception of the figures for the two phase servomotor, are based on a 5 hp, 1750 rpm rating. The two phase motor data apply to a small sub-fractional horsepower instrument type motor.

In this connection, it should be pointed out that variation in mechanical time constant with size of a particular type of drive is surprisingly small. For example, the mechanical time constants of d-c motors with constant field current, or of rotary hydraulic motors, vary only about two to one in the range of sizes from 1 to 100 hp. Values given in the table for the d-c motors include effect on the mechanical time constant of the armature resistance of the generators supplying the motor. Likewise, the figure for the hydraulic motor includes the effect of leakage in the pump supplying the motor.

Effect of Load

In designing a system, effect of the load must be included in computation of mechanical time constant. No load effects are included in the data of Table 1.

The time constant of the combination of drive members and load is the ratio of the drive member inertia plus the load inertia to the drive member damping plus the load damping. Load damping is defined as the change in load torque per unit speed change and depends upon the nature of the load. For example, in the case of a blower load, torque required varies as the square of the speed, and the damping factor, which is inversely proportional to the slope of the speed-torque curve of the load, varies directly as the speed.

On the other hand, for a metal working load such as a rolling mill or wire drawing machine, torque required is essentially independent of speed, and the damping contributed by the load is zero. In any case, load damping at any particular speed must be added to the drive member damping at the same speed in order to compute the mechanical time constant at this speed.

Load characteristic can have an important effect on performance of a feedback control system, particularly in those cases where the damping coefficient of the driving member under certain required conditions of operation is low. When the combined damping of load and drive member is insufficient to give satisfactory system performance, damping must be provided synthetically by means of tachometer feedback or rate circuits. The effectiveness of such synthetic damping, however, is seldom as great as an equal amount of real damping because the former is subjected to the time delays in the amplifying components of the system.

TABLE 1—MECHANICAL TIME CONSTANTS OF 5 HP, 1750 RPM DRIVES

Type of drive	Mechanical time constant, sec	Remarks
Hydraulic motor with variable displacement pump	0.004*	Constant
Constant field d-c motor with adjustable voltage generator	0.035	Constant
Two phase a-c motor**	0.01—0.04	Varies with torque and speed
Adjustable field d-c motor with adjustable voltage generator	0.035—0.55	Varies with field strength
Eddy current coupling	0.025—inf.	Varies with torque and speed
Magnetic particle clutch	5.0—inf.	Varies with torque

*Piston and cylinder drive will usually have lower time constant depending on piston leakage and inertia.
**Two phase motor data are for low torque, instrument type servomotor instead of 5 hp rating.

Importance of Other Factors

The typical feedback control system is at best a combination of components that require, in general, analytical or experimental work, or both, to insure satisfactory performance and good stability. There is obviously much more to the design of a good servo system than choice of the best output driving element.

Suitable devices or circuits for measuring the regulated quantity, for providing the reference, for matching these two quantities, and for amplifying the error signal must be selected; and consideration must be given to the time delays or transfer functions of each component to insure satisfactory transient response. In many systems, special phase advancing networks or other stabilizing devices are required, and special care must be used in fitting these devices to the system.

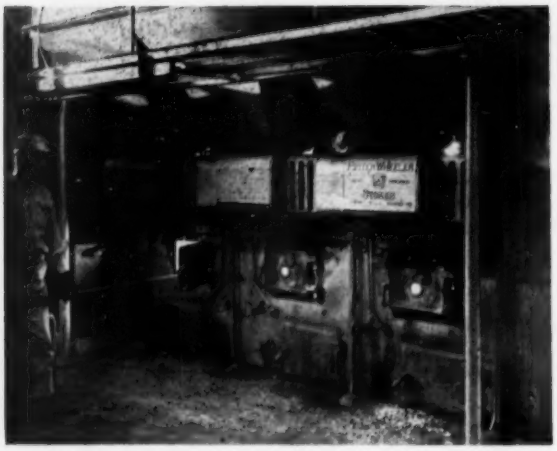
Attention must also be given to other characteristics of the drive member besides the mechanical time constant. For instance, if a d-c motor and generator are to be used, time delays associated with inductance of the motor armature circuit and generator field circuit must be considered if an optimum control system design is to be achieved. In a hydraulic drive such factors as pump displacements, compressibility of the oil, presence of air in the oil, volume of oil in the system, and elastic expansion of the pipes may be important.

It has been noted that the mechanical time constants of most of the drives discussed above vary with operating conditions. Associated with this variation is an accompanying variation in the amplification factor or gain of the drive member. This factor may be defined as the change in torque per unit of control quantity or as the change in speed per unit of control quantity, whichever is applicable. Gain variations are caused partly by non-linearity in the control characteristics and partly by curvature in the speed-torque curves. These gain variations must be investigated when designing control systems since they can have an important effect on system performance.

Summary

For optimum performance of an automatic control system, a drive member having a mechanical time constant and a gain that do not vary is preferable. If rapid response to changes in the reference quantity is a criterion of good performance, then the mechanical time constant should also be as small as possible. When a driving member does not possess these preferred characteristics but must be used to conform with other requirements, some impairment of performance can be expected in at least part of the operating range.

From a paper presented at the 1952 Annual Machine Tool Electrification Forum sponsored by Westinghouse Electric Corporation.

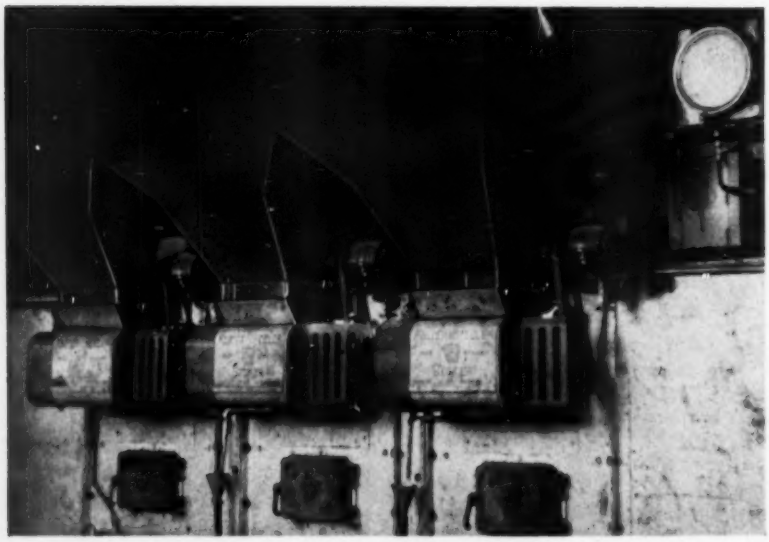


Steam plant operator at Fort Frances stirs up lignite fuel bed in one of the spreader stoker fired furnaces

Improvements at Kenora included the installation of a pneumatic system for automatic removal of lignite ash

LIGNITE FIRING PROVES ECONOMICAL AT TWO MANDO PLANTS

Minnesota and Ontario Paper Co. has reduced steam plant operating costs and increased capacity at their Kenora and Fort Frances, Ontario mills by installing new spreader stokers and converting from bituminous coal to lignite firing



Spreader stoker shown above is one of four units that were installed at the Kenora plant. Three boilers at Fort Frances also have been converted

PRODUCTION RECORDS of the Minnesota and Ontario Paper Co. show substantial savings in steam costs have been experienced since boiler plant improvements were completed. New spreader stokers, furnace alterations including the addition of water cooled walls, and improved ash handling facilities have combined to lower fuel costs, provide a much needed increase in steam capacity, and reduce maintenance expenses. In addition, the company now enjoys the major advantage of flexibility since either bituminous coal or lignite can be utilized.

Four boilers at the Kenora, Ontario newsprint mill and three at the Fort Frances, Ontario pulp and paper mill were converted to the use of lignite fuel. A fourth boiler at Fort Frances still burns bituminous coal but will be converted to lignite operation when the unit is replaced. At the International Falls, Minn paper and insulation board mills, however, conversion to lignite operation seems doubtful in the near future. Because of the distance from the lignite fields in North Dakota and resultant high transportation costs, lignite is less attractive as a fuel for this plant than bituminous coal.

Source of Fuel Supply

Both Kenora and Fort Frances receive their lignite from strip mines located in the Bienfait area in southern Saskatchewan. If coal were used at these plants, it would have to be shipped either from the western part of Alberta or from the United States. As a result, high transportation costs plus duty when coal is shipped from the United States make lignite the less expensive of the two fuels. Furthermore, because the source of lignite is close to the Canadian mill towns, sup-

ply would be less affected in case of a national emergency, and possible shortages caused by sudden defense needs or other developments in the coal industry would be averted.

Since installation of the spreader stokers at Kenora started in 1948 and was completed by the fall of 1950, it is best to examine the figures for operations at this plant before and after conversion to lignite firing. Prior to 1948, the four Kenora boilers consumed more than 35,000 ton of bituminous coal annually at a cost of $392,000 based on current market prices. In 1951 fuel costs were somewhat less as operation with lignite proved more efficient.

The new spreader stokers replaced underfeed stokers that were installed in 1925, the year the present Kenora steam plant began operation. Their installation involved tearing out the old units plus changes in the brick and steel settings of the old boiler units. This effort was justified because after 25 years of operation, these stokers were badly worn and required extensive repairs. Therefore, it was decided to replace them since only bituminous coal could be fired on the underfeed stokers while spreader stokers can operate with either coal or lignite.

Increased Capacity

Spreader stokers are especially suitable for lignite firing and provide many fuel burning improvements. There are no moving parts within the furnace and fuel bed depth is reduced greatly at full steam load. The addition of water cooled walls effectively protects the furnaces from excessive temperatures and provides an additional steam capacity of 40,000 lb per hr. These features have reduced maintenance and replacement expenses to a minimum when compared with the costs of underfeed stoker operation. All Kenora units have performed very successfully with over-all efficiencies being quite comparable to other types of fuel and equipment.

As lignite is a strip mining operation, coal is transferred from the seams to freight cars without stockpiling. On arrival at the Kenora plant, the coal is still frozen as it comes from the seam and is free running from the cars. The only time that trouble is experienced with lignite sticking in the cars is when a car is delayed in transit long enough for the inherent moisture to sweat out and freeze in the car. This condition occurs so seldom that Kenora's coal handling problems have disappeared since converting to lignite.

Lignite Analysis

An average analysis for lignite received at Kenora during the month of December 1951 is as follows:

Per cent moisture	33.72
Per cent ash	5.84
Per cent sulfur	0.55
Heating value, Btu per lb	7178

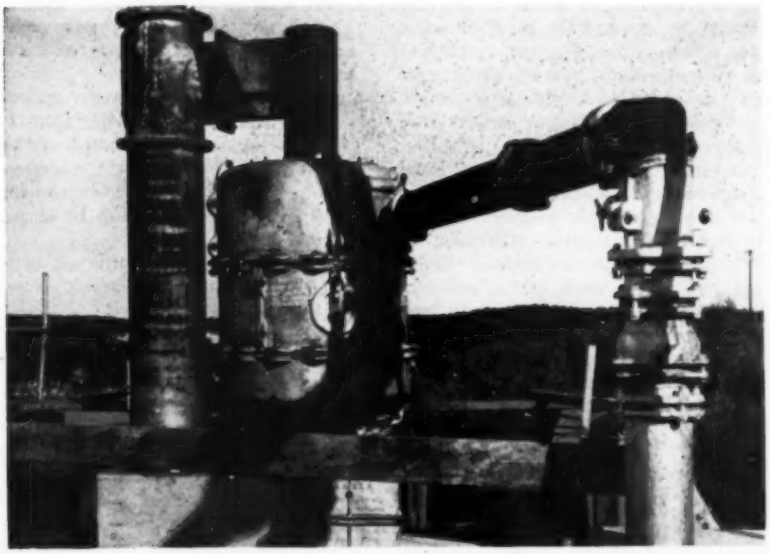
The bituminous coal previously fired produced 14,000 to 14,500 Btu per lb.

With the use of lignite coal, new ash removal problems arose both at Kenora and Fort Frances. When coal was used prior to 1948, the ash was sprayed with water and handled in ash cars. But, lignite ash cannot be wet down without having the ash pack in the pit, making removal difficult.

At Kenora this problem was solved by installing a pneumatic system that transfers the ash from the pit to a receiver tank. At this point, the ash is unloaded into rail cars with the help of a dustless loader equipped with a rotating mixing drum and water sprays. As the drum rotates, a scraper bar inside mixes the ash with the water. The bar also sends the wet lignite ash down a chute to a waiting rail car. This whole operation is automatic and can be started or stopped by pushing a remote control button.

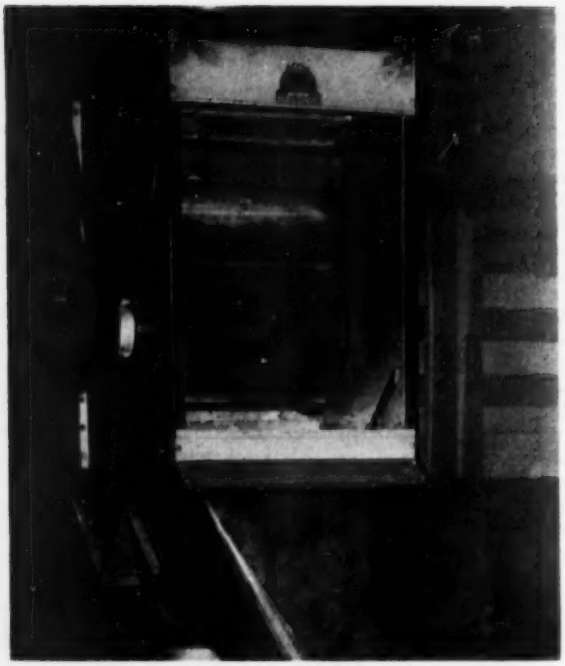
Ash removal at Fort Frances is quite different from the method used at Kenora. At the Fort Frances mill, the ash is first passed through a crusher and then sluiced hydraulically through a pipe line out into the mill yard. This system can be used at Fort Frances because soft coal ash that includes clinkers is mixed with the dusty lignite ash.

At Fort Frances, coal and lignite ashes are mixed and sluiced to the mill yard



Ash from this outdoor receiver is loaded into rail cars with the help of a dustless loader equipped with a rotating mixing drum and water sprays

Operator checks furnace conditions in one of the boilers fired with lignite



Cocoa beans pass over a magnetic drum while metallic impurities cling to the drum and are removed automatically

Magnetic separator picks cigarettes, that contain foreign metal, off the production line before they go to packaging

INVESTIGATING MAGNETS FOR PROTECTION

INCREASED USAGE of permanent, non-electric magnetic separators is becoming more and more prominent in the chemical, textile, metalworking, food, and rubber industries. These devices have prevented millions of dollars worth of damage due to iron and steel inclusions in foods, chemicals, and other products. Manufacturers have saved even more money because of this protection against machinery damage, fires, and explosions.

Philip Morris and Co., Ltd., for example, subject their tobacco and cigarettes to three major magnetic separation tests for purity. No expense is spared to assure delivery of a perfect cigarette to the smoker.

Fires caused by tramp iron were frequent at Woodside Mills, Greenville, S. C. However, when two permanent magnets were installed the fires were completely eliminated. Savings were estimated at well over $2500 annually, on property alone.

Magnetic separators are accepted as integral parts of coal chutes, slurry lines, belt conveyers of all types, bucket elevators, foundry sand revitalizers, liquid flow lines, food processing lines, and other materials-handling systems. Ranging in size from 2 in. to well over 12 ft, they are doing a notable job in separating tramp iron from non-magnetic materials.

Most common non-electric industrial magnetic separator is the plate type, consisting of a series of Alnico magnet castings mounted on alloy or stainless steel-faced plates. Angle of repose can be as much as 45 deg from the horizontal. Application is for spouts, chutes, hoppers, and tables.

Where installations are made at 45 deg or more—for pneumatic lines—a flow-interrupting unit known as a magnetic pump is installed. It utilizes two or more plate magnets and is effective where materials to be protected are moving at high velocities.

For fully automatic separation of tramp iron from non-ferrous materials such as coal, sand, gravel, and rubber conveyed on belts a magnetic pulley-type device is used. As contaminated material reaches the pulley, powerful Alnico magnets attract and hold to the belt all undesirable iron and steel. The cleansed product falls off the pulley at the natural tangent point, and the tramp metal falls later as it is conveyed out of the magnetic field.

A separator similar in principle to the magnetic pulley is the magnetic drum. It consists of a revolving cylindrical shell that contains a stationary high-powered non-electric magnet. Drums are installed in conveying systems not using bolts. They remove medium-fine ferrous contamination from grain, ceramic sands, crumb rubber, and chemical powder.

Pipe-line magnetic separators are being used to protect liquids, slurries, glazes, oils, and semi-liquid foods carried in pipes from stray iron and steel inclusions.

Micro-magnetic separators remove iron particles ranging in size from 16 mesh (of a size big enough to go through a wire screen with 16 openings per linear inch) down to 400 mesh. The parent mass can be almost as fine.

When minute amounts of non-magnetic material must be separated from large quantities of magnetic material, a device combining mechanical agitation and magnetic separation has proven valuable.

Possibilities open to industrial magnets are innumerable. Not only have they paid for themselves in protecting manufacturers from machinery breakdowns, fires, and product contamination, but in some cases insurance companies have granted reductions in premium rates where they are installed.

Power transmission

Engineering data and information to aid in selection, application and operation of equipment used in transmission of mechanical power

BEARING FAILURES AND THEIR CAUSES--2

JOSEPH L. BRUSCA, *Senior Design Engineer, SKF Industries, Inc.*

Failures Due to Incorrect Machining of Shafts and Housing

If the specified shaft diameter is exceeded, or the housing bore undersize, the internal radial clearance of the bearing may be removed because of inner ring expansion and outer ring contraction.

Both conditions will cause an overload and flaking (sometimes known as spalling) of the races or balls. This condition may be recognized by the appearance of the parts under load—their surfaces are chipped and flaked. It differs from wear since surfaces are rough, rather than smooth. This is the normal way for a bearing to fail after long service under load. When this occurs in a short period of time, then the bearing has been overloaded by some outside cause.

Normal fatigue failures generally show a load track around the circumference of one ring and over one section of the other. Should the load track appear at two or more places in one race, then internal loading is indicated.

For example, should the housing bore be out of round or undersize, the outer race will be squeezed out of shape, causing overload. In a cartridge mounting, the housing bore may be correct when disassembled, but when inserted into a machine frame, which is bored undersize, it may be squeezed out of round.

Distortion of the housing bore may occur if the pedestal on which the pillow block is bolted is not straight or smooth. The dimension of the housing may be correct, yet pinching a bearing in a split housing is possible if the bearing is not seated squarely in the bearing seat. If the cap is bolted down with the bearing in this position, pinching will take place across the diagonal corners of the outer ring.

Loading of bearings, which are pinched in their housings because of cocking, is very evident upon examination. A definitely defined load track will be noticeable on opposite sides of the outer race across the same diagonal where the pinching occurred.

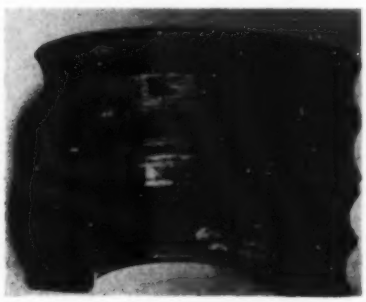
Bearings mounted on a tapered shaft or on a tapered adapter sleeve can be overloaded at the time of mounting. Should the inner race be forced up on the taper too far, it will expand excessively, and the normal internal radial looseness in the bearing will be removed. When mounting ball bearings of this type, rotate the outer race continually as the bearing is forced up on the taper. At the first sign of binding the inner race has expanded as much as it should.

In a spherical roller bearing, when mounted on a tapered shaft or sleeve, both the amount of initial internal radial clearance and the necessary expansion of the inner ring are such that the decrease in internal clearance can be measured with a feeler gage. Thus, the reduction may be checked in accordance with manufacturers' specifications.

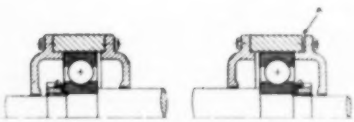
Extreme care must always be exercised to insure proper shaft and housing fits. Undersized shafts and oversized housing bores will also cause early bearing failures. An undersized shaft will permit the inner ring to rotate on the shaft—while an oversized housing bore will permit the outer ring to spin in the housing. Both conditions will cause heat, smearing of the parts that rub, and rubbing cracks—all of which may lead to early failure.

Failures Due to Incorrect Mounting and Abuse

Misalignment of either race of a deep groove bearing will impose an undetermined load, which together with the normal load will cause an



Undersized shaft and oversized bore caused slippage and race smearing



Exaggerated condition of preloading two bearings. When end cover, right, is brought up flush with its housing an overload will be imposed on both bearings. This condition is usually caused by omission of the proper shim between end cover and housing

Pitting due to electric action can be the cause of noisy bearing operation

overload condition resulting in early failure.

Misalignment also imposes undue stress on the retainer. In fact, this condition and poor lubrication are the main causes of retainer failure. If misalignment is present, it will be indicated by a ball track not parallel to the edge of the groove. When the misaligned path is in the outer race (in applications where the inner race rotates) then the housing bore is not parallel with the edge of the groove, the inner ring might be cocked on the shaft, the shaft shoulder not square with the bearing seat, or the shaft may be bent.

Sometimes a condition like this can develop in the case of a cartridge housing mounting. The bearing may be mounted perfectly in the cartridge, but when the unit is not bolted squarely to the machine frame misalignment may result.

Another cause of initial overloading is an opposed mounting, which binds the outer races and causes excessive thrust. Most mounting designs require that one bearing be held within its housing shoulders while all other bearings on that same shaft are allowed to float free in the housing. However, there are mounting designs, which require that the outer races of two bearings be opposed. For example, opposite sides of the two bearings are mounted against the shoulder of each housing. The spacing between these housing shoulders must be quite accurate in relation to the distance between the bearing shoulders on the shaft. Otherwise, excessive initial end thrust will be imposed on the bearing.

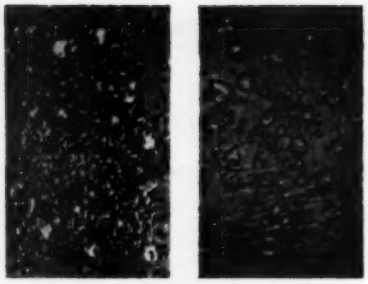
Pitting resulting from electric action causes noisy bearing operation. This occurs in electric motors and generators when electric current passes through the bearing from the frame to the shaft. Actually a crater is burned in the steel by the arcing of the electric current. Under severe conditions, the craters can be seen with the naked eye. Smaller ones require high magnification.

Bearings becoming ball dented and operated in this condition will be very noisy. Ball denting or brinelling is the result of excessive pressure on the races through the balls when the bearing is not rotating. This is a common occurrence in small bearings that are mounted in the housing while the inner race is on the shaft. Such impressions are produced when the outer race is tight or becomes cocked in the housing, and pressure to force it into position is applied through the inner race.

When impact is in an axial direction, the balls can be nicked as they are forced against the edge of the groove. Ball dents are easily distinguished from dents produced by chips or dirt, because they are usually spaced the same distance apart as the position of the balls. Ball dents can be produced in the bottom of a groove if sufficient impact should pass through the balls in a radial direction. If a motor is dropped from a shelf to the floor and the overhanging end of the shaft strikes first, then denting of this nature could take place.

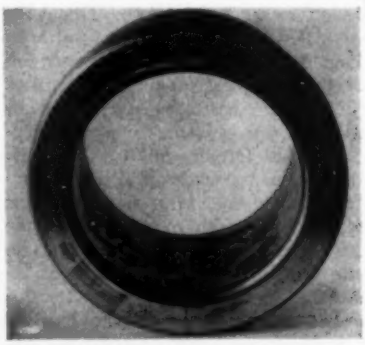
Another condition similar to ball denting is known as pocketing or false brinelling. In this condition, the pockets are also spaced the same distance apart as are the balls or rollers, and because of this, it is often confused with denting. The cause, however, is entirely different and is caused by vibration while the bearing is not rotating. If a shaft is supported by the bearings in transit, and the parts are not bound tightly together, small pockets might be produced in the tracks. Such false brinelling would also be likely to take place if two separate units are mounted on a common base and only one is operated at a time. The vibration caused by running one unit will cause the balls or rollers of the other, which is not running, to jiggle against the races and produce these small pockets. They can be distinguished from ball dents, especially if the race is examined with a magnifying glass, as the polishing lines in the race have been worn away at each pocket. On the other hand, ball dents depress the surface (deformation), and the polishing lines will continue on through these depressions.

When bearings are examined—thought to have a flat ball—it is found that the noisy condition was caused by something entirely different. Defects in material or hardening are rarely the cause of early bearing failure or noisy bearings. Another misconception is cracked inner races of small bearings. In most instances, the shaft is found to be oversize and the inner race was expanded excessively. Also, the inner race may have been forced on the shaft while it was in a cocked position.



Craters, left, are caused by the passage of electric current through bearing. Burns, right, are due to arcing

Wear, similar to ball denting, resulted from vibration while machine was idle



This undersized ring was cracked when it was forced onto an oversized shaft

Abusive treatment of bearing is shown by the hammer marks on surface of ring

Bearings, although in common use every day, are precision units. They must be treated with common sense care if they are to perform as expected

No Pressure Wipe-Off on Gears Lubricated with Sun 897 Grease

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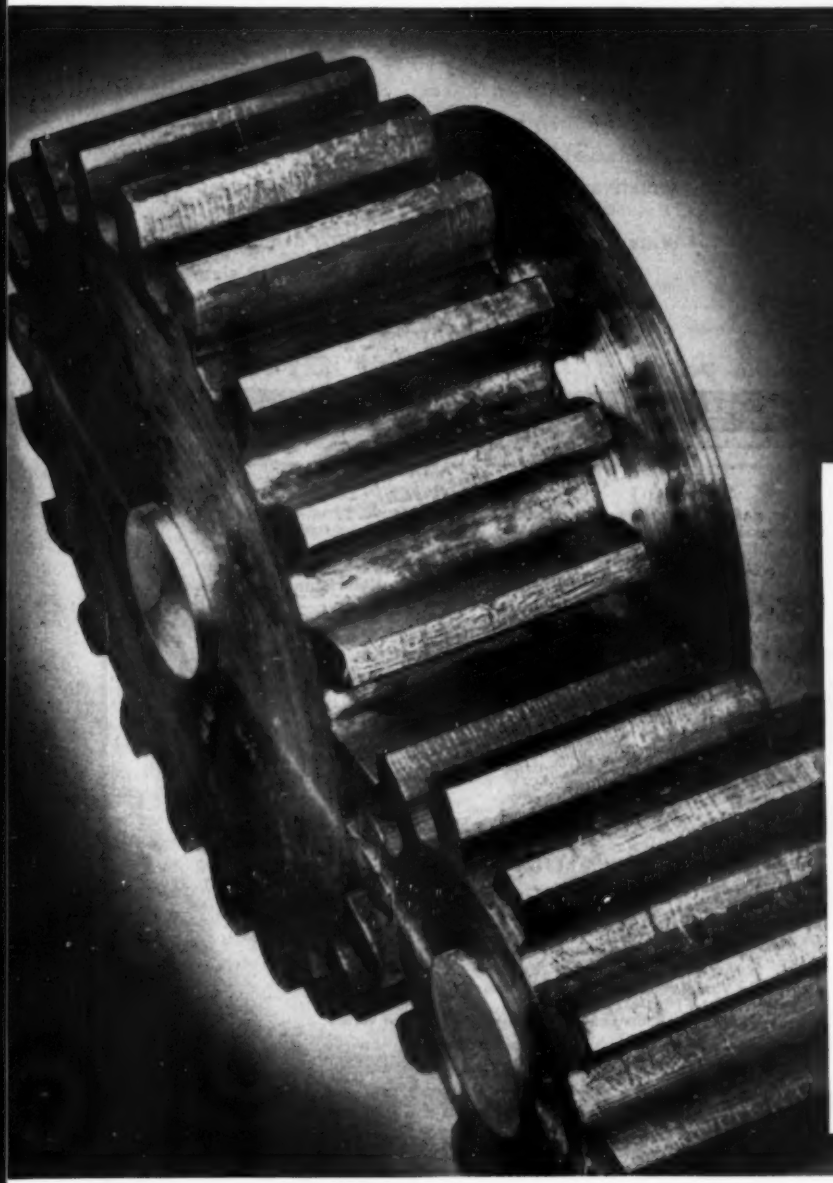

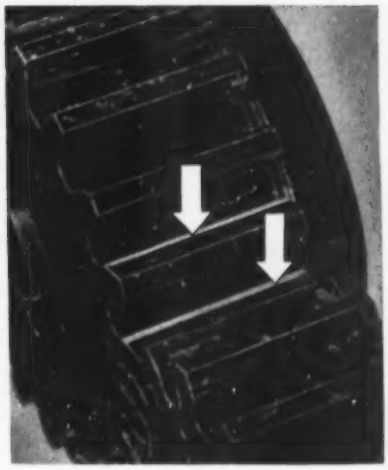

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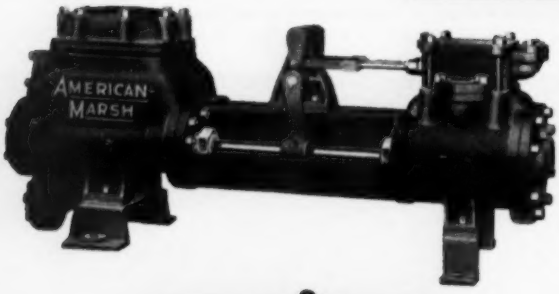

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Report On

ALUMINUM ELECTRICAL CONDUCTOR

THERE IS NOTHING NEW about aluminum as a conductor of electricity. Aluminum conductor has served well and long for 45 years in transmission and distribution lines.

What is new about aluminum is that there is so much of it being produced, with prospects of a great deal more. Production is bringing the price down and today it is only a few cents a pound. In fact, it costs less per pound than copper and, due to the lightness, a pound has approximately the same current carrying capacity as two pounds of copper. Aluminum is about 62 per cent conductive as compared to 99 per cent for copper.

At the peak of the defense program, with copper in very short supply, pressure was placed on the electrical industry to convert to aluminum conductor. The school construction program, for instance, was given an allotment of 7,000,000 lb of copper where 10,000,000 lb per quarter were needed. All the aluminum it wanted within reason was available.

Reports persisted from various parts of the country that electrical contractors were reluctant to use aluminum conductor, that "electricians" considered it an inferior conductor, that it was not safe, and that it was difficult or impractical to install.

No industry group has been more sensitive to the increasingly acute copper supply outlook than the electrical contractors. Their national trade organization, the National Electrical Contractors Association, commenced studying substitute conductors on Korea Day.

Likewise, several leading manufacturers commenced a similar study intent upon developing proper materials and equipment.

The industry quickly came to the conclusion that aluminum was a very good substitute for copper as a conductor, provided certain characteristics were taken into account.

The Problems

An aluminum conductor having current carrying capacity comparable to copper must be larger. The proper size is approximately one conductor size or two wire gages larger. That is, a No. 12 aluminum wire is necessary to conduct electricity as well as a No. 14 copper wire, and so on. That calls for larger conduit sizes, imposing a problem of basic, original engineering on any electrical job.

Secondly, aluminum wire, being larger and more brittle, was difficult to use and did not handle well on wiring devices such as switches and terminal points made for the smaller, more ductile copper. Then, too, aluminum wire of early manufacture was mean to handle. Mechanics complained that it was "dirty", meaning the oxidation stained.

Third, and perhaps the most serious problem was that of the connection. For one thing aluminum oxidizes instantly on contact with the air and the thin layer of oxidation is an effective insulation sheath.

Also when copper and aluminum are in contact in the presence of moisture a serious electrolytic condition sets in and could destroy the connection and develop a dangerous situation.

These three problems were ones primarily of design and manufacture —the proper design of the electrical system, sized to accommodate the larger sizes of aluminum conductor, and manufacture to overcome basic mechanical and electrical problems.

The Solutions

The first problem, the larger size of conductor, is simply one of design. When the qualified electrical contractor is called in by the owner or the awarding authority at the start, the system may be properly designed and sized in respect to conduits for aluminum. The electrical contractor should not be blamed for being reluctant to use aluminum when asked to bid on plans drawn for copper. The basic design differs in important respects. Owners and awarding authorities will find consultation in the early stages of planning with qualified electrical contractors a time and money saving step in any construction project.

Manufacturers of wire and cable have overcome most of the problems involved in the second consideration, that of brittleness and difficulty of handling aluminum wire.

And manufacturers have developed techniques for the completely safe and efficient connection of aluminum to aluminum, and aluminum to copper or other conductive metals. Anyone who takes the time to study the few differences between copper and aluminum can handle aluminum readily.

QUALIFIED CONTRACTOR, official publication of the NECA, published in June, 1952, a concise and highly informative article on aluminum conductor, particularly on connection problems involved, by M. D. Bergan of The Thomas & Betts Company. The Burndy Engineering Company, Inc., is another connector manufacturer that has done research and de-

Abstracted through the courtesy of the National Electrical Contractors Association, Incorporated.

velopment on aluminum connections.* The following paragraphs are some of the highlights of Mr. Bergan's article:

Aluminum does not reveal its final behavior at once. Conventional copper connectors installed on aluminum cable inevitably fail. These failures are not available in laboratory tests or in accelerated aging tests. An actual installation test is the only sure method of determining a proper connection.

Aluminum is covered with a film of oxide whenever it is exposed to the air. It is like a film of insulating enamel and is practically nonconductive. For good electrical contact this film must be broken.

It is not difficult to clean off this oxide on a solid aluminum wire. But with stranded conductor, each separate strand has its own film. There is high resistance between one strand and the next as though the cable were stranded of insulated wires, like a telephone cable. If only the outside strands were cleaned, then only the outside strands carry the full current. For a conductor to carry its full load, all the wires that comprise the cable must be brought into good electrical contact with one another and the connector.

The oxide film can be removed by scraping, by chemical dipping or by fine abrasives. On cable this cleaning is only temporary. Fluxes, acids and caustics are not advisable since they only mean built-in failures. The solution for cable is a solderless pressure connector of a type recommended for aluminum. The best is one that will clamp around all strands uniformly with sufficient pressure to break the oxide film.

A filler compound is essential to remove oxide from the surfaces and seal the cable from the air. It may be zinc chromate primer paste thinned with linseed oil, petroleum jelly or a light mechanical grease. The compound is smeared thickly over the aluminum surface and the metal scrubbed with a wire brush or emery cloth through the compound. It has no effect on electrical quality of the joint, but seals against air and new aluminum oxide films. Some compounds have zinc particles that bite or grind into the aluminum surfaces, assuring a firm connection. The excess should be removed as it might adversely affect the insulation.

Thermal Effects

As an aluminum cable becomes warm from current passing through it, it expands about 38 per cent more than copper and will shrink in a similar proportion when the temperature drops. The aluminum cable, under heat, quickly gets too large and something has to give. Stronger than the aluminum cable, the copper alloy connector will not stretch. The result is that the aluminum cable extrudes a little out of the connector. When the joint cools again, the extruded aluminum cable is a little smaller than it was at first, and the connector is not so tight on the cable. This cycle, repeated over and over again, obviously destroys the firm connection and makes higher resistance and more heat, and eventually the joint fails.

Exhaustive tests showed that connectors for aluminum cables should have the same thermal expansion as the cable.

Corrosion

When two different metals are pressed together and get wet, they make a miniature electric cell. Salty and industrial atmospheres improve the cell. Potentials as high as 2 v have been generated between copper and aluminum. As the miniature cell generates electricity, one of the metals is corroded like the zinc plate in a wet battery. With a copper connector on an aluminum cable, the aluminum corrodes and damages the connection.

Certain simple precautions will prevent this corrosion. One is to keep moisture from the joint. Another is to tinplate aluminum lugs that are to be bolted to copper. Tin is a buffer metal, not so positive as aluminum and not so negative as copper. Used between copper bus and aluminum lugs, it prevents the two different metals from forming an electrolytic cell.

When copper cable is spliced to aluminum cable, another possibility of corrosion is prevented by use of liners. The two-way splicer is made of aluminum, but the end to receive the copper cable has a tin coated copper sleeve inside it as a buffer. A zinc chromate or petroleum jelly filler is recommended for the joint.

Damage by Pressure

Fourth difference is that aluminum used in conductors is not so hard or so tough as comparable copper cable. Under pressure aluminum flows more readily than copper. Connectors for aluminum, then, should have wide surface contact with the cable to distribute pressure and keep any part of the cable from being damaged through over-compression. Connectors should be designed to grip aluminum cable all around. Thus, connectors made for one cable size only are advised.

It is possible to make solder terminals of aluminum neat and small but one can never be sure that the solder has made a firm electrical band, and corrosive fluxes can create havoc.

Best practice seems to be use of pressure connectors. They cost less per piece than the bolted type of fitting. The electrical contractor must invest a considerable sum in the proper tools for this work, but that investment in tools is the hallmark of the qualified electrical contractor.

Conclusions

1. Manufacturers have developed products and basic techniques which if carefully followed make the use of aluminum conductor safe and efficient.

2. In the long run, the metal to be preferred will be that one which is the most economically feasible for the job, which means a combination of price and adaptability for the use intended.

3. At this time, comparative prices of basic aluminum and copper metals and the limitations of wiring devices and terminal connections now in use and in manufacture indicate that today only in the larger sizes—somewhere in the size range as large as or larger than No. 6 wire and cable—is aluminum economically feasible. Slight savings in price of aluminum conductor in the smaller sizes (No. 12 and No. 10 for instance) may be offset by costly additional man-hours required for installation.

4. Extensive surveys, made by NECA, of suppliers of basic metals, manufacturers of wire and cable, electrical material, equipment, apparatus and appliances show conclusively that at this time aluminum conductor is not economically feasible for branch circuit wiring. There appears, barring large-scale war, sufficient copper in prospect to meet all branch circuit needs. Accordingly, manufacturers of materials, apparatus and appliances are generally foregoing large investments necessary to change terminal connections to accommodate aluminum conductor on the small branch circuits.

5. On larger wires and cables and bus, even down to service entrance cable for homes, aluminum is being widely accepted and used. For outside conductor on transmission lines it has become the dominant type of conductor.

6. The degree to which aluminum conductor is used will be determined by the simple economic factor of price.

7. But before the electrical contractor can use aluminum, or even bid an aluminum job, provision for its use must be made in the design in the initial stages of planning. This also insures maximum benefits accruing from the availability of aluminum.

* "Cable Connectors for Aluminum Conductors", F. A. Westbrook, INDUSTRY AND POWER, July, 1952.

News
of men and companies

SOCIETIES

American Society of Mechanical Engineers—D. H. Cornell, mgr of engineering services for The B. F. Goodrich Company, is appointed to serve on the Professional Divisions Committee.

Sigma Xi—T. O. Kuivinen, chief engineer's ass't, The Cooper-Bessemer Corp., is elected to full membership in recognition of outstanding contributions to the engineering field.

ANNOUNCEMENTS

Sims Pump Valve Co.—Will move to their recently purchased plant in Hoboken, New Jersey early this month. The new plant provides a great increase in production facilities.

SALES OFFICES

Dynamatic Corp.—This subsidiary of Eaton Manufacturing Co. announces the opening of a Philadelphia office at 4525 North Broad St. E. Pohl is mgr.

The Foxboro Co.—Opens a new branch office at 2207 South Pinecrest, Wichita, Kansas. Appointed resident engineer at the new office is D. G. Hugley, who moves to his new assignment after several years of service with the Tulsa branch as industrial engineer.

APPOINTMENTS

The Goodyear Tire & Rubber Co.—S. Dupree, asst mgr of the industrial products div since 1947, is named asst to R. S. Wilson, v-p in charge of sales.

S. Dupree J. R. Cella

Crane Co.—J. R. Cella is appointed mgr of the newly created purchased industrial sales section. His assignments include engineering sales, marine sales and water and sewage works sales section.

Hyatt Bearings Div.—F. H. Webster is appointed mgr of the western div sales office in Chicago. He succeeds C. L. Newby who has retired after 34 years' service.

Iron Fireman Corp.—Announcement is made of the promotion of S. H. Beach to industrial sales mgr.

Hills-McCanna Co.—Announces the appointment of V. M. Barber as advertising mgr.

Southern Coal Co.—C. I. Johnson joins the organization and is appointed to the sales staff. He will cover the Greater Chicago area.

C. I. Johnson L. B. Schueler

Diamond Power Specialty Corp.—L. B. Schueler, sales mgr since 1950, is elected to v-p in charge of sales.

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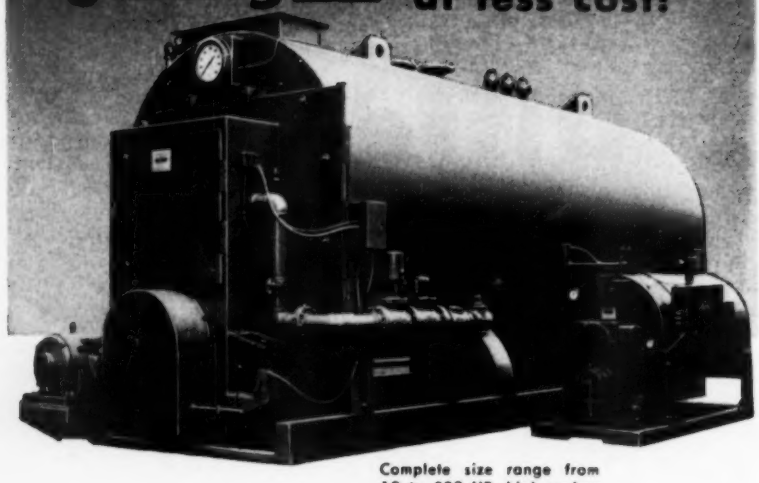

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You save on cost with Continental Automatic Boilers because, factory assembled and shop-fire tested, they are ready to operate after simple service connections in your plant. No special stack or foundation required. No baffles or refractory to replace or repair. This means front and back covers can be opened to provide quick, easy access to furnace and tubes.

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News
of men and companies

(Continued from page 105)

NEW REPRESENTATIVES

The Hilliard Corp.—Jules D. Gratiot Co., 1101 Riverside Drive, Los Angeles, Calif., is appointed representative in California.

Orr & Sembower, Inc.—Announces appointment of The Combustion Equipment Company, 4809 N. Claremont Ave., as its distributor in the Chicago territory.

Pennsylvania Flexible Metallic Tubing Co.—Appoints as their distributor in the New Orleans territory the firm of Murray-Baker-Frederic, Inc., 626 S. Peters St.

Rust-Oleum Corp. —T. S. Walsh, Hillsdale, N. J. becomes the new factory representative for the complete line of rust-preventive products in metropolitan New York and northern New Jersey. The Industrial and Farm Equipment Corp., Chester, Penn., is appointed farm and industrial distributor and will carry the complete line.

The Terry Steam Turbine Co.—A new concern called Somes & Nick Co. now represents the company in the sale of steam turbines and gears in Chicago.

Warren Webster & Co. and The Ric-wiL Co.—Announce changes in representation in New York City and the immediate area. The Ric-wiL Co. moved into a new office at 215 East 37th Street. J. F. Hanbury, former New York district representative for Webster and Ric-wiL, becomes mgr of the new office, with C. G. Mencke as asst mgr. Warren Webster & Co. will continue its office at 95 Madison Avenue with K. C. Steeneck as the new district representative.

APPOINTMENTS

Vapor Heating Corp.—Announces appointment of W. C. Keeran, as executive engineer. In his new post he will supervise all phases of engineering, research, and design of the company's products. He also will continue as v-p in charge of Roth Manufacturing Co.

W. C. Keeran **G. A. Gade**

Standard Pressed Steel Co.—G. A. Gade is made vice president in charge of sales. He succeeds to a post left vacant by the election almost a year ago of J. Friel to vice president.

Allis-Chalmers Manufacturing Co.—H. F. Banzhaf is named to the newly created post of manager of sales of control operation, Hawley Works. Other new appointments for the Hawley Works include H. A. Wright as asst mgr of sales; T. B. Montgomery, chief engineer; H. W. Cory, asst chief engineer; T. H. Bloodworth, engineer in charge, industrial control design, and H. E. Reichert, engineer in charge, railway and marine design. A. I. Thorsen, works mgr of the Norwood Works, returns to Milwaukee as asst director of manufacturing of the general machinery div. J. F. Costigan, asst works mgr at Norwood, is named the new works manager replacing Thorsen.

Dearborn Chemical Co.—Announces the election by the board of directors of R. F. Carr, Jr., as v-p. He will make his headquarters in Chicago and will work with sales dept heads.

Chain Belt Co.—Announces the appointment of B. G. Schneider to the newly created post of asst chief engineer, conveyer equipment section.

Elliott Co.—S. K. Hostetter, Jr. is the new sales mgr of the Crocker-Wheeler Div. at Ampere, N. J.

Crane Packing Co.—C. E. Schmitz is appointed v-p in charge of sales. He formerly held the position of v-p and director of engineering. In a reorganization of the sales dept under Mr. Schmitz there are to be five div sales mgrs; E. H. Stubenrauch, mechanical packings; S. Hawxhurst, molded teflon products; H. I. Sole, lapmaster; V. E. Vorhees, mechanical seals; and S. Segar, plastic lead seal. Another oppointment announced was that of A. J. Solari to the position of chief engineer, mechanical seal div.

C. E. Schmitz T. A. LaBrecque

The Hilliard Corp.—T. A. LaBrecque is elected a v-p and will continue as mgr of the purifier div in charge of sales and engineering.

Johns-Manville Corp.—The appointments D. L. Hinmon, as asst to the genl mgr of the industrial products div; and A. J. Bette as product mgr for friction materials; E. H. Wells, as asst to the merchandise mgr; and G. R. Wahl, as asst product mgr for Transite pipe; are announced.

Pennsylvania Flexible Metallic Tubing Co.—R. T. Patriquin takes over new duties as New York sales mgr.

Westinghouse Electric Corp.—R. E. Ballentine is named plant mgr of the new welding-electrode plant being constructed at Montevallo, Ala. Sturtevant Div. announces appointment of W. B. Cott as mgr of air conditioning application engineering. He fills a post left vacant by the death of T. E. Smith.

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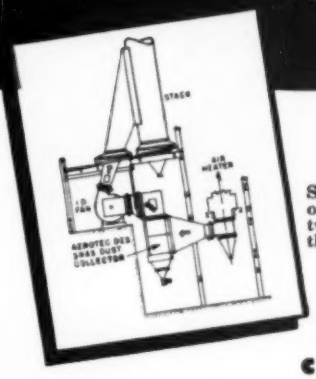


Sectional drawing shows location of AEROTEC Dust Collector between air heater and I.D. fan at this Riverton Station.

Promote your community relations

the highly efficient Aerotec way

A clean stack has proven time and again to pay valuable dividends in community good will. To gain this advantage, plus plant erection and maintenance economies, public utilities are specifying the Aerotec Design 3 RAS Dust Collector. This unit develops a higher centrifugal force through the use of multiple, small-diameter tubes, resulting in exceptionally high efficiencies on ultra-fine dusts.

Flexible and space-saving

The tubes are permanent mold aluminum and closely nested to provide lighter weight and more capacity per square foot of plan area than any collector of comparable efficiency. They are set at a 45° angle on vertical tube sheets, factory-assembled into lightweight "building block" sections that reduce installation time and permit the Aerotec Design 3 RAS to be easily tailored to fit available space.

Our field engineers specialize in solving flyash collection problems and welcome the opportunity to assist you at any time. Call or write. No obligation.

Project Engineers

THE THERMIX CORPORATION
GREENWICH, CONN.
(Offices in 38 Principal Cities)
Canadian Affiliates: T. C. CHOWN, LTD.
Montreal 25, Quebec Toronto 3, Ontario

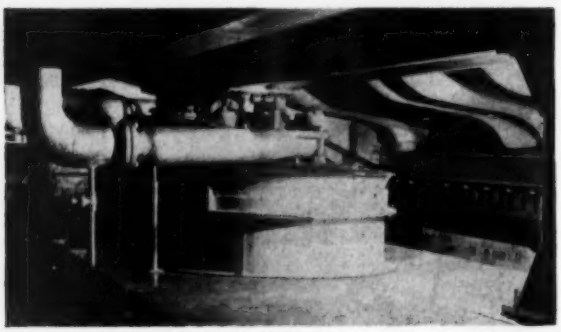
THE AEROTEC CORPORATION
GREENWICH, CONN.

Spot news

Short, "boiled-down" paragraphs on the most interesting recent events and developments in American industrial plants

Axial-Flow Type Blower Meets Space Requirements at Squibb

When the pharmaceutical firm, E. R. Squibb & Sons, recently expanded production at their New Brunswick, N. J. plant, a corresponding increase in steam generation was needed. To supply the additional load, it was decided to supplement two existing units, rated at 40,000 and 100,000 lb per



hr, with a 165,000 lb per hr Babcock & Wilcox steam generator. Serious space limitations were encountered, however, which meant that selection and location of auxiliary equipment had to be carefully engineered.

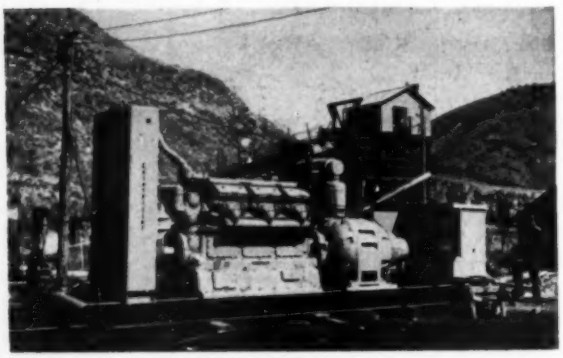
An interesting example of how space was saved is found in the selection of forced draft equipment. Because of its compact size, engineers of the L. J. Wing Manufacturing Co. recommended an axial-flow type blower. A turbine driven unit having a capacity of 47,000 cfm at 5 in. static pressure and 1850 rpm was selected. Flow of air is vertically downward. Measurements of this unit are 54 in. diameter by 35 in. high.

Compactness of the unit permitted mounting directly underneath the rear boiler overhang, and still allowed adequate room for servicing. The selection of the axial-flow type over a centrifugal type blower is reported to have eliminated at least 10 ft of addition to the boiler room, thus resulting in a substantial saving.

Show Horse Becomes Work Horse Overnight

When fire recently knocked out all power units at Red Wing coal mine, Axial, Colo., prompt action was called for to restore operation. The local distributor for Caterpillar Tractor Co. responded to the emergency by obtaining permission to use a Caterpillar D397 electric set which had been set up for display in an exhibit at the American Mining Congress in Denver.

Power lifts hoisted the skid-mounted engine from its splendor in the exhibit, and a truck rushed it to the



Skid-mounted electric set, installed to provide emergency power for Red Wing Coal mine, can deliver 315 kw

smoking ruins at Axial. Installation was begun immediately and emergency power was putting the mine back into production a few hours after it arrived.

Space in the exhibit was filled in with posters explaining in detail that the show engine had responded to a call for emergency duty.

New Tool Simplifies Removal of Battery Covers

One of the common repairs to industrial storage batteries involves the removal of a damaged cover. In many batteries, particularly rubber-jar types, the post openings are lined with lead inserts integral with the cover. Since these inserts

The Cover—New Oil Horizons

Discovery of oil in the Dakotas has opened up an entirely new field for crude petroleum. Drilling equipment is being erected, and pumping has started in many locations.

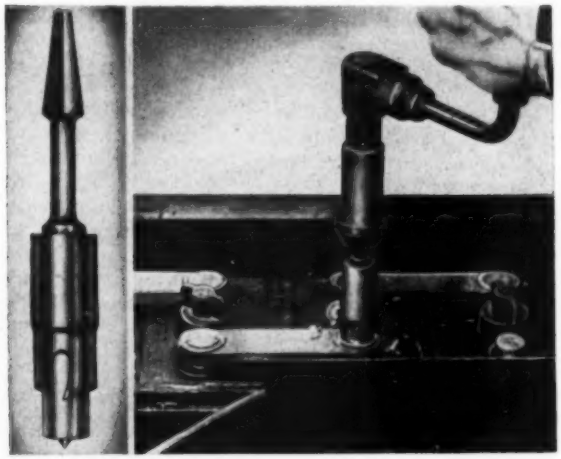
In this month's cover an American Steel Erector's derrick is silhouetted against the sky in the process of setting a new cat cracking plant for the Northwestern Refining Co. This is the beginning of a new industry for the Upper West.

Acknowledgment is made to American Crosby Clipper, published by American Hoist & Derrick Co.

or linings are welded to the battery posts to prevent leaks, it is necessary to drill out gaps between posts and inserts.

One method is to drill the posts to a depth of ⅜ in., using a 15/16 in. drill. This frees the inter-cell connector. Such drilling may then be continued through the cover to free it in turn. The posts must then be rebuilt before assembling in a new cover. This is done by a lead puddling process in which heat is applied by a carbon electrode manipulated within the cavity of a simple post mold.

To simplify this procedure, Gould-National Batteries, Inc. has developed a special drill which cuts an annular hole



Special drill shown at left permits removal of cell connectors and jar covers without disturbing terminal posts

and permits the lead posts to remain solid, upright and of normal height after the cell connector and the jar cover have been separated.

Instrument Manufacturer Predicts Wider Use of Industrial Controls

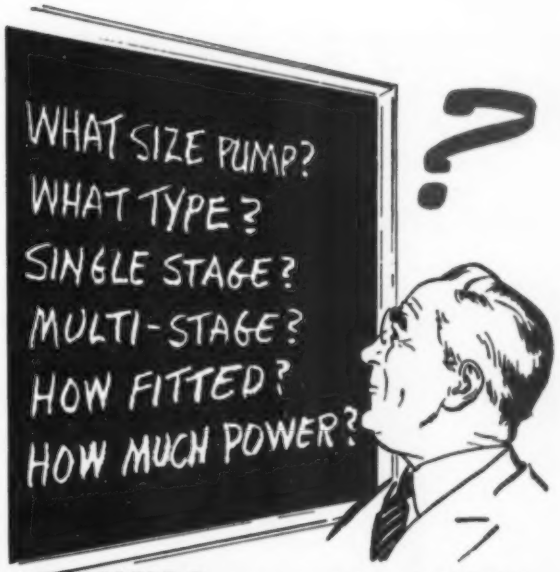
One of the significant industrial trends during the past year was increased use of instrumentation and automatic control equipment. This continued investment in 1952 showed a 10 per cent rise over 1951, and represented many new applications for both new and old instruments. H. F. Dever, president of Brown Instruments Div. of Minneapolis-Honeywell Regulator Co., predicts a continuation of trend toward wider use of instruments and controls.

Reporting on the growth of automatic operation in industry, Dever pointed out that rates of expenditures for measuring and control instruments have increased twice as fast in the last 15 years as capital expenditures as a whole. This, he explained, provides the best index available for determining how far automation has gone.

He pointed out that instrument sales will, by 1955, have doubled purchases of 1950. This follows a pattern of increasing volume set by annual sales which have multiplied by some 10 times since 1930. In this same period, instrument's share of the capital expenditures for new plants and equipment has risen from 0.2 to 1.2 per cent.

The chemical industry, long a leader in aggressive use of industrial technology and instrumentation, faces the prospect of doubling production of nearly a dozen major

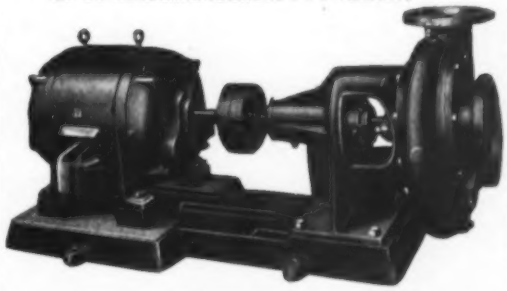
(Continued on page 110)



IF PUMPS ARE YOUR PROBLEM, CALL IN A WEINMAN SPECIALIST...

Selection of the right pump to handle a specific liquid handling problem, calls for skilled judgment backed by years of experience. That's why thousands of pump users have put their pump selection problems in the hands of a Weinman centrifugal pump specialist. For more than 50 years these Weinman specialists have helped pump users in every type of industry, and with every kind of liquid handling problem to get the results they wanted to put their pumping operations on a paying basis.

Basic design, precision manufacture and progressive research make Weinman centrifugal pumps first choice for low initial cost, year-round operating efficiency and virtually maintenance-free service. So, take your fluid handling problems to a specialist —your nearby Weinman representative, who KNOWS pumps. Write, wire or phone for his recommendations . . . TODAY.

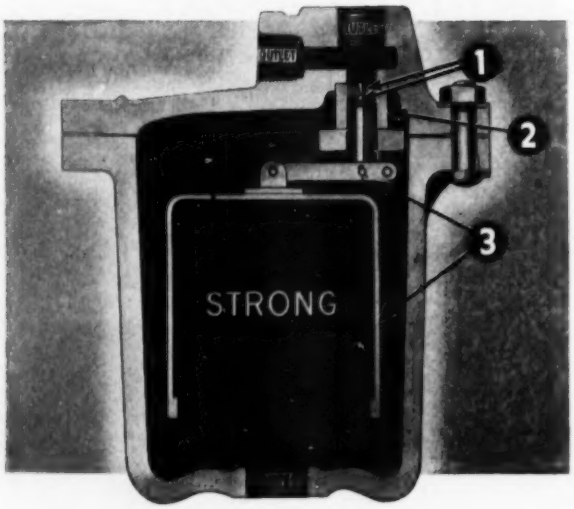


Representatives in principal cities

Sold by Centrifugal Specialists

The WEINMAN Pump Mfg. Co

3 Reasons STRONG* Traps are easy to maintain!



Look for these three STRONG low-maintenance features in the STRONG 80 Series Inverted Bucket Trap:

1. **Anum-Metl Valve and Seat—guaranteed leakproof for one year;**
2. **Bolted-in seat design—insures tight seal, easy servicing;**
3. **Stainless steel bucket and trim.**

Compare these features with other traps!

STRONG 80 Series Trap sizes ½" to 2½", pressures to 250 lbs., temperature to 500° F. (forged steel for higher pressures).

Dual outlet simplifies piping, bottom inlet keeps trap cleaner. Years of trouble-free operation assured by super-STRONG construction.

Catalog No. 68-H describes inverted, open bucket and other types of STRONG traps. Write today.

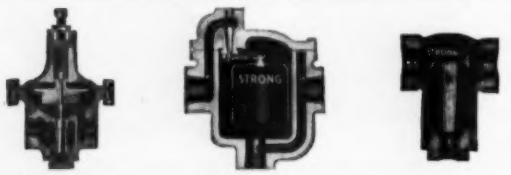
*Trade Mark Reg. U. S. Pat. Off.

STRONG, CARLISLE & HAMMOND COMPANY

1392 West 3rd Street
Cleveland 13, Ohio

ANUM-METL Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES



Reducing Valve | 70 Series Trap | Strainer

STRONG

Spot news

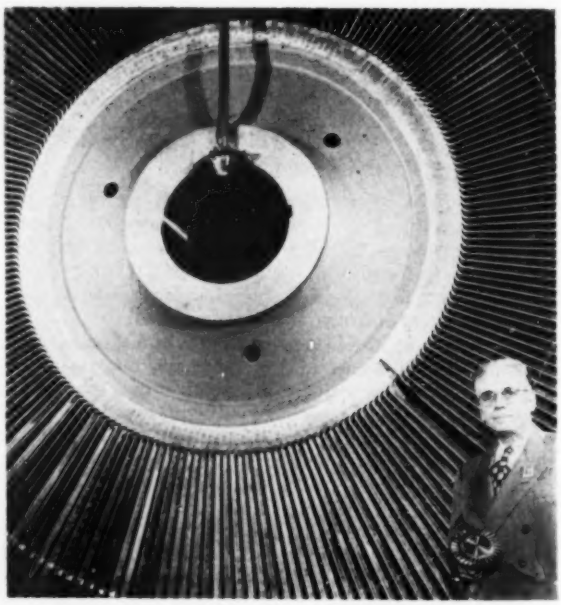
(Continued from page 109)

chemicals to meet defense production targets. In addition, there is the work being done in fluocarbons, mining and metallurgical chemicals, as well as the search for lubricants, alloys and refactories which will withstand higher temperatures and pressures. Increased use of automatic controls will help meet this formidable challenge, Dever said.

He also predicts that increasing diversity of petroleum products will create new technical problems that the instrument and petroleum industries must solve together. Petrochemistry will need the support of the instrument industry to continue its advances. Processes for obtaining synthetic fuels from natural gas, oil shale and coal, now in the development stage, will of necessity require precise instrumentation.

"There is also," Dever said, "the market for instrumentation represented by the obsolescent plant. Because of the war and post-war defense effort, hundreds of new plants in almost every segment of industry include the most modern technological advances, thus making for efficient operation and low costs. In comparison, thousands of older plants are approaching technological obsolescence and, in periods of intense competition, will have to modernize or die."

These few examples, according to Dever, illustrate that is is not by coincidence that the industrial instrument demand continues heavy and that the outlook from the viewpoint of the instrument maker is optimistic.



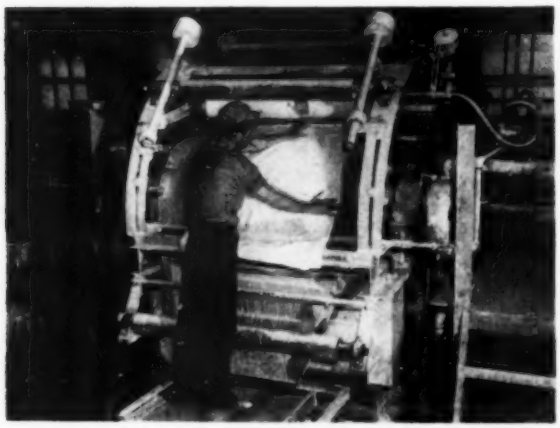
LARGEST TURBINE WHEEL DWARFS SMALLEST

Glenn B. Warren, general manager of the turbine division, is shown holding the smallest turbine wheel manufactured by General Electric during 1952. It has a diameter of less than 6 in., and revolves at 34,000 rpm in a supercharger. The largest, shown in the background, is 14 ft in diameter and revolves at 1800 rpm in a steam turbine

Synthetic Filter Cloth Withstands Strong Caustics

Foote Mineral Co., Philadelphia, Pa., reports the use of Dynel filter cloth in their rotary vacuum presses. In operation, the cloth completely resisted plugging and readily separated from the filter cake. In addition, it outlasted the materials it replaced, thus reducing the number of shutdowns and the cost of replacement.

In recent tests, the material was subjected to 50 per cent concentrations of sodium hydroxide and 28 per cent concentrations of ammonium hydroxide. According to the manufacturer, the Textile Fiber Dept. of Carbide and Carbon Chemicals Co., the only loss of strength was 6 per cent noted in the filling of the Dynel immersed in sodium hydroxide. No physical changes or shrinkage were observed.



Workmen at Foote Mineral Co. are shown installing Dynel filter cloth on a rotary vacuum press

Manufacturer Reports Progress on Construction And Design of Three Nuclear Power Plants

Although nuclear power plants on a production line basis are a long way from reality, the fact that plants of major size are now under construction and design give some definition about the present status of the science of controlled nuclear energy.

Westinghouse Electric Corp. reports that it has three such plants now under construction or design. One is a land based prototype of a submarine atomic plant. It is located at the National Reactor Testing Station near Arco, Idaho. The second plant will power the submarine Nautilus, and manufacture has been started on many of the components. In the reactors for both of these plants, water is both the moderator and the primary coolant fluid. In the Nautilus, nuclear energy will be put to use for large scale control-power utilization for the first time.

The third project concerns the design and development of another nuclear power plant many times larger than those mentioned above. It is planned that this power plant shall be suitable to power major naval vessels, however it could well be a forerunner of the reactors which someday can be used to produce useful power for homes and industry.

(Continued on page 112)

That's the word of a large midwest manufacturer. Twenty-one years of service without need for repairs prove to him that, with a GRID installation, first cost is last cost. Such service records (GRID installations made in 1929 are still operating) are the rule rather than the exception with GRID Unit Heaters because GRID was deliberately designed to be a better unit heater. To provide not only ample, comfortable heat, but to give years of service without the usual high maintenance cost generally experienced with ordinary unit heaters. Such service records occur because GRID is completely different from other unit heaters—Here's how:

GRID is an all cast unit with finned heating sections and headers tested to withstand steam pressures up to 250# P.S.I.

GRID construction uses no brazed, soldered, rolled or welded connections between condenser and headers. A specially designed threaded nipple assures a precision, leak-proof fit.

GRID construction has all similar metals in contact with steam, thus preventing electrolytic corrosion which eventually occurs in copper type unit heaters where steam passes from iron pipes into copper cores. (Write for booklet CORROSION IN UNIT HEATERS).

GRID construction resists corrosion from fumes present in most types of industry.

GRID design incorporating low outlet temperatures, proper fan sizes and motor speeds, assures delivery of warm comfortable air in ample volume to the working level. No stratification of warm air at the ceiling to waste your fuel dollars.

These are the reasons why users of GRID Unit Heaters get 21 years and more of trouble-free service. There are units cheaper than GRID, but there is none better.

You start saving money the day you install GRID Unit Heaters.

GET THE COMPLETE GRID STORY—WRITE FOR CATALOG CUH-848-A.

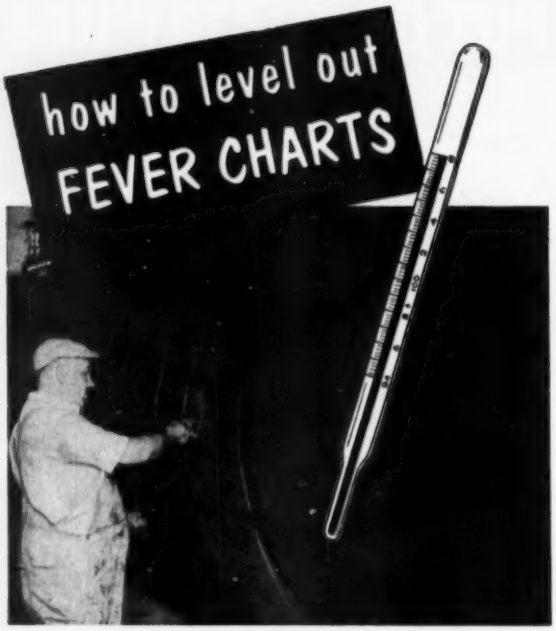
GRID Blast Coils are ideal for process drying—Write for Catalog BC-1049.

REPRESENTATIVES IN PRINCIPAL CITIES

D. J. MURRAY MANUFACTURING CO.

MANUFACTURERS SINCE 1883

WAUSAU, WISCONSIN



Easily applied, highly efficient.....Ideal for maintenance work.....

No. 1 Insulating Cement

Here is the low cost answer to cutting heat losses on all types of equipment. B-H No. 1 Insulating Cement may be applied over block or blanket—or direct to large and small irregular surfaces not suited to preformed insulation. It has high coverage, low volume shrinkage—and contains a rust-inhibitor which prevents corrosion of equipment.

B-H No. 1 is effective up to 1800° F. and is 100% reclaimable when removed from equipment heated up to 1200° F.... If you have any problems of selection or application of any insulating material, put the job up to B-H Engineered Insulation Service.

Baldwin-Hill

Clip on signed letterhead and mail

TEAR OUT

BALDWIN-HILL COMPANY
834 Breunig Ave., Trenton 2, N.J.

Please send complete information on

- ☐ NO. 1 INSULATING CEMENT... All-purpose, rust-inhibiting, plastic cement
- ☐ MONO-BLOCK... Rigid, felted black rockwool block—for high and low temperature use
- ☐ POWERHOUSE CEMENT... High adhesion, black rockwool insulating-finishing cement
- ☐ BLANKETS... Metal-reinforced, flexible, felted black rockwool insulation

Spot news

(Continued from page 111)

New Development Speeds Production of Cold Rubber

Development of a lower cost process which makes cold rubber 50 times faster than current methods has been announced by J. L. Collyer, president of The B. F. Goodrich Co. Collyer stated that the new process, developed by B. F. Goodrich Chemical Co., is the result of 12 years of research by company scientists, and that it had been perfected under a research contract financed by the Synthetic Rubber Div. of Reconstruction Finance Corp.

Production of high quality rubber by the new process requires 15 to 20 minutes, as compared to 10 to 12 hours required by present production methods. The new development, which is still in the pilot plant stage, is described as a continuous pipeline process made possible by development of extremely active catalysts.

Small size and simplicity of equipment used by the process eliminates the need for much expensive equipment and reduces the size of the buildings required to house production facilities. Company engineers estimate that cost of buildings and equipment could be reduced at least 50 per cent.

"The long history and high cost of basic research and group effort behind this development is typical of important technological advances in the chemical industry today," Collyer said. "The new faster process apparently offers unlimited opportunity for the production of improved rubbers at lower costs—progress of interest to all users of tires and many other products in which American rubber is used."

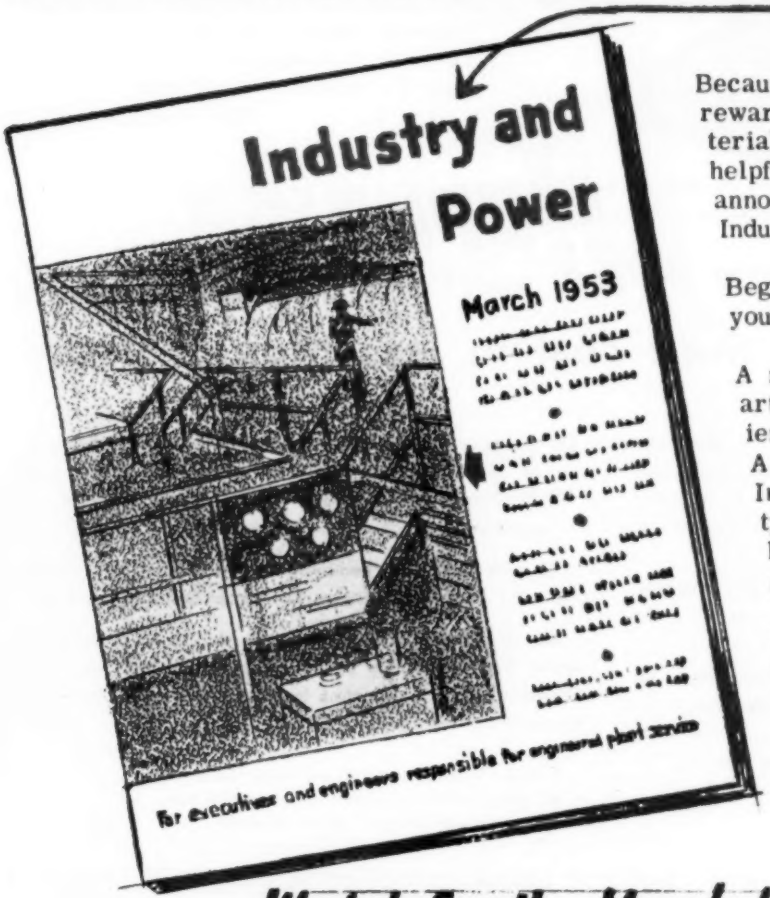
—End

ENGINEERS INSPECT GIANT TURBO-BLOWER

Steel mill and engineering representatives inspect one of the largest blast furnace turbo-blowers ever built in this country. The giant blower, one of a pair built by De Laval Steam Turbine Co. for Armco Steel Corp., is a 5-stage unit with rated capacity of 121,000 cfm of air at 35 psi discharge. It will be driven by a 15,200 hp, 2500 rpm, 16-stage steam turbine designed to operate with 400 psi, 750 F steam and vacuum of 28 in.

Coming—

a new cover—
a new, easier-to-read format
for YOUR FAVORITE ENGINEERING MAGAZINE



Because our objective is to give you rewarding, profitable editorial material — in an ever-handier, more helpful form — we are pleased to announce an improved, streamlined Industry and Power.

Beginning with our March issue, you will find:

A new cover design, with major articles featured for your convenience and reference.

A new simplified index page.

Improved, easier - to - read typography. Restyled article layouts. New, attractive departmental headings.

We hope these improvements will please you—and help make Industry and Power more than ever your favorite technical magazine!

Watch for the March Issue of
Industry and Power

420 MAIN STREET, ST. JOSEPH, MICHIGAN

this is the plant . . .

Unusually compact arrangement allowed for the installation of all three units in a boiler room only 20' x 60'

. . . . where 3 SUPERIOR STEAM GENERATORS saved more than their cost in less than 2 years

Only four years ago, this plant was inadequately heated with coal at a fuel cost (excluding labor) of approximately $44,000. per year. Three years ago, three Superior Steam Generators were installed with the following three results:

(1) Fuel costs were cut to $22,000 . . . and in less than two years, those Superior Steam Generators saved their total cost.

(2) The ability of those Superior Steam Generators to deliver their full rated capacities provided steam in excess of that required for heating . . . which was sold as process steam to further reduce the cost of operation.

(3) Because of their compact design, a substantial saving in space resulted; and the space thus saved was profitably rented to still further reduce the cost of operation.

To meet increased demands for process steam, a fourth Superior Steam Generator has recently been installed.

This is but one of the many case studies which demonstrate the advisability of investigating the installation of Superior Steam Generators in your plant. For complete details write for Catalog 502.

Superior Steam Generators are fully automatic; burn oil, gas, or both. 18 sizes from 20 to 600 b.h.p. for pressures up to 250 p.s.i. or for hot water.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR STEAM GENERATORS

3 *special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in*

ENGINEERED PLANT SERVICES

1. NEW EQUIPMENT

Begins on page 8

Contains highlights of new products by leading manufacturers, briefed and illustrated for your easy reference. Complete data on each of these products are available ***free.***

2. NEW BULLETINS

Begins on page 126

Includes descriptions of only those bulletins and catalogs that are really ***new*** and of ***direct value*** to you — saves your reading time, yet gives you full service. All bulletins sent to you ***free*** on request.

3. READERS GUIDE TO ADVERTISED PRODUCTS

Begins on page 117

Designed to catalog advertised products for your convenience in finding the ads which are of special interest to you at this time. Also lists those important bulletins, catalogs and working data offered ***free*** in the advertisements.

REQUEST CARD FOR LITERATURE OR MORE INFORMATION—Feb., 1953

To: INDUSTRY AND POWER, St. Joseph, Mich. Please have forwarded to me, at no obligation, the literature I've indicated by the following key numbers:

New Equipment begins Page 8	*New Bulletins begins Page 126*	*Advertised Products begins Page 117*
No.'s	No.'s	No.'s

Your Name_____ Title_____

Your Company_____

Co. Address (St. & No.)_____

City_____ State_____

Inquiries for items listed in this issue not serviced beyond June 1, 1953

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ST. JOSEPH, MICH

3 special departments featured monthly to give you FREE bulletins, catalogs and product data screened for your personal interest in

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Your Company _____

Co. Address (St. & No.) _____

City _____ **State** _____

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Readers' guide to advertised products

This department is both a product index for advertising and a keyed listing for advertised literature. Refer to advertisement on page indicated and contact advertiser directly — or list paragraph key numbers on reader service card (page 115) to get data you want

AIR & DUST FILTERS & COLLECTORS

Dust Collectors
Adv. p 107 contains information on Aerotec design 3 RAS dust collector. The Thermix Corp.

Dust Collector **500**
Bulletin contains full information on the Buell 'LR' dust collector. Buell Engineering Co. p 120.

BOILERS & BOILER ACCESSORIES

Condensers
Adv. p 35 contains information on Worthington condensers. Worthington Corp. Steam Power Div.

Steam Generators **501**
Descriptive literature on Wickes' complete line of steam generating equipment. The Wickes Boiler Co. p 141.

Steam Generating Units
Adv. p 22, 23 contain information on Riley steam generating units. Riley Stoker Corp.

Vertical Unit Boilers
See adv. p 25 for information on C-E vertical unit boilers. Combustion Engineering-Superheater, Inc.

Baffles
Adv. p 135 contains information on Enco boiler baffles. The Engineer Co.

Electronic Feedwater Control **502**
Bull 52-1073-221 gives full information on Hays electronic feedwater control system.. The Hays Corp. p 53

Steam Generating Units **503**
Bulletin contains data on Vogt two-drum steam generators. Henry Vogt Machine Co. p 52.

Boilers
Adv. p 128 contains information on Kewanee steel boilers. Kewanee-Ross Corp.

BUILDING HEATING, VENTILATING, AIR CONDITIONING & REFRIGERATION

Grid Unit Heaters **504**
Catalog CUH-846-A contains complete story on Grid unit heaters. D. J. Murray Mfg. Co. p 111.

Trane Torridors **506**
Bull DS-327A contains data on Trane Torridors for packaged heating, ventilating and air filtering unit. The Trane Co. p 42.

BUILDING MATERIALS & MAINTENANCE

Pipe Joint Compound **507**
Free sample of Key-Tite water-proof sealing compound. Key Co. p 139.

Iron Cement **508**
Free Repair Handbook describes Smooth-On repairs. Smooth-On Mfg. Co. p 138.

Floor Patch **509**
Coupon on page 125 offers complete details of trial order plan and Handbook of Building Maintenance. Flexrock Co.

Metal Grating **510**
Free booklet contains information on Klemp diamond riveted grating. Klemp Metal Grating Corp. p 105.

Maintenance Handbook **511**
Coupon on p 133 offers free handbook on commutator and slip ring maintenance. Ideal Industries, Inc.

COAL, ASH & BULK HANDLING

Concrete Stave Silos **512**
Full details on Marietta industrial storage systems and precast insulated concrete wall panels. The Marietta Concrete Corp. p 127.

Coal Handling Equipment **513**
Bull 300 contains data on G-W basic designs of coal handling. Gifford-Wood Co. p 62.

Coal Handling Equipment **514**
Book 2345 describes Link-Belt car shaker, Book 2048-A describes rotary car dumper. Link-Belt Co. p 4.

COMPRESSORS

Compressors **515**
Bull L-667B1B contains complete information on Worthington YC-2 compressors. Worthington Corp., Compressor Div. p 26.

CONTROLS, REGULATORS & INSTRUMENTS

Thermometers **516**
Literature describes all-metal as well as glass and electrical thermometers. Weston Electrical Instrument Corp. p 124.

Temperature Control **517**
Bull 329 contains data on Powers No. 11 temperature indicating regulators. Powers Regulator Co. p 136.

Tank Gage **518**
Details available on Liquidometer tank gage. The Liquidometer Corp. p 125.

Truscale Gage **519**
Catalog describes Truscale gages for positive distance reading of liquid levels. Jerguson Gage & Valve Co. p 123.

Regulators **520**
Bull 100 gives full details on wide line of automatic regulating valves. Spence Engineering Co., Inc. p 59.

ELECTRICAL DISTRIBUTION

Circuit Breakers
Adv. p 10, 11 contains information on I-T-E circuit breakers. I-T-E Circuit Breaker Co.

Capacitors **521**
Booklet GEA-5632, "How to Use Capacitors to Reduce Power Costs and Gain System Capacity." General Electric Co. p 43.

(Continued on page 118)

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Readers' guide to advertised products

(Continued from page 117)

ELECTRICAL HEATING UNITS

Electric Heaters **522**
Cat 50 describes many types of Chromalox electric heaters and how to apply them. Edwin L. Wiegand Co. p 37.

ENGINES

Engines
See adv. p 47 for data on CP engines for straight diesel, dual fuel, or gas operation. Chicago Pneumatic Tool Co.

FANS & BLOWERS

Centrifugal Blowers **523**
Coupon on p 2 offers centrifugal blower catalog B-10 with complete data. Hartzell Propeller Fan Co.

Blowers **524**
Coupon on p 21 offers data on blowers and exhausters. Coppus Engineering Corp.

FILTERS, STRAINERS & PURIFIERS

Strainers **525**
Bull 184 contains data on Armstrong strainers for steam, air, gas, water and oil lines. Armstrong Machine Works. p 140.

Twin Strainers **526**
Bulletin contains service-giving features of Elliott twin strainers. Elliott Co., Accessories Dept. p 134.

Automatic-Drain Filter **527**
Complete data available on this automatic-drain filter for removing moisture in compressed air lines. C. A. Norgren Co. p 132.

FUELS & FIRING EQUIPMENT

Coals
Information on Bell & Zoller coals. Bell & Zoller Coal Co. p 63.

Coals **528**
Complete data on Southern's engineered, industrial coals. Also free booklet on the storing of coal. Southern Coal Co., Inc. p 33.

Coals
See adv. p 14, 15 for information on bituminous coals. Bituminous Coal Institute.

Oil Burners **529**
Coupon on p 19 offers the Petro catalog of commercial-industrial oil and gas-oil firing equipment. Iron Fireman Mfg. Co., Petro Div.

Coals
Adv. p 102 contains data on this product. General Coal Co.

HEAT EXCHANGER EQUIPMENT

Water Heaters
Adv. p 60 offers full information on P-K water converters and storage heaters. The Patterson-Kelley Co., Inc.

Aero After-Cooler **530**
Bulletin contains information on Niagara Aero After Coolers. Niagara Blower Co. p 131.

INSTRUMENTS FOR MEASURE OF ELECTRICITY

Hook-On Volt-Ammeter
Adv. p 36 contains data on G-E hook-on volt-ammeter that stays accurate. General Electric Co.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Non-Fluid Oil **531**
Bull 504 and free testing sample of Non-Fluid oil. New York & New Jersey Lubricant Co. p 133.

Diesel Lubrication
Adv. p 57 contains data on Garcon oil for diesel lubrication. Sinclair Refining Co.

Lubricant **532**
"Lubriplate Data Book," a valuable treatise on lubrication. Lubriplate Div., Fiske Brothers Refining Co. p 136.

Adhesive Pressure Grease
Adv. p 101 contains data on Sun 897 adhesive pressure grease. Sun Oil Co.

Oil Purifiers **533**
Literature describes complete line of Hilco purifiers, filters, reclaimers and conditioners. The Hilliard Corp. p 6.

Turbine Oil
Adv. p 49 contains information on Nonpareil turbine oil. Standard Oil Co.

MATERIALS OF CONSTRUCTION

Nickel Alloy
Adv. p 54 contains information on "S" Monel. The International Nickel Co., Inc.

MECHANICAL POWER TRANSMISSION

Steel Collars **534**
Literature describes solid steel collars. Hallowell Power Transmission Div., Standard Pressed Steel Co. p 140.

Roller Bearings
Adv. p 51 contains information on Hyatt roller bearings. Hyatt Bearings Div., General Motors Corp.

Condor V-Belts **535**
Bulletin 6868 contains engineering facts on Condor V-belts. Raybestos-Manhattan, Inc., Manhattan Rubber Div. p 61.

Flexible Couplings **536**
Catalog and handy selector charts on Lovejoy flexible couplings. Lovejoy Flexible Coupling Co. p 136.

Conveyer Belts
Consult the Goodyear Technical Man for your needs in conveyer belts and other industrial rubber products. Goodyear Tire & Rubber Co. p 3.

Grommet V-Belts
Adv. p 48 contains information on Goodrich grommet belts. The B. F. Goodrich Co., Industrial & General Products Div.

V-Belts
Adv. p 9 contains information on Gates Vulco rope. The Gates Rubber Co.

MOTORS & GENERATORS

Motors **537**
Bull GEA-5813 contains complete information on the new G-E boiler-feed-pump motor. General Electric Co. p 33.

PACKAGED STEAM GENERATORS

Packaged Steam Boilers **538**
Illustrated and descriptive Cleaver-Brooks steam boiler catalog available. Cleaver-Brooks Co. p 45.

Packaged Automatic Boilers
Information available on Continental packaged automatic boilers. Boiler Engineering & Supply Co. p 106.

Packaged Boilers **539**
Catalog gives facts on Powermaster packaged boiler with Voriflow combustion. Orr & Sembower, Inc. p 56.

Superior Steam Generators **540**
Catalog 502 contains complete details on Superior packaged steam generators. Superior Combustion Industries, Inc. p 114.

(Continued on page 120)

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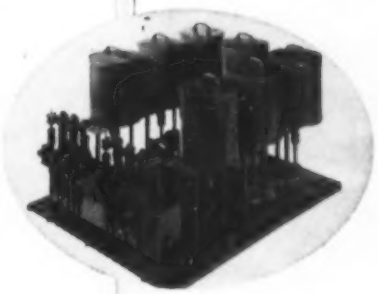

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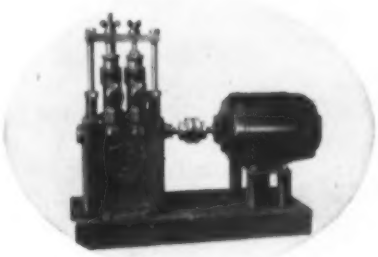

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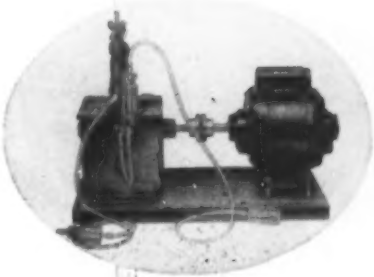

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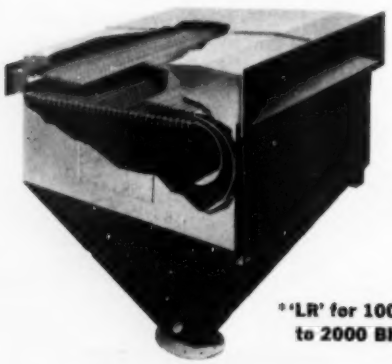

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Readers' guide to advertised products

(Continued from page 119)

PIPE, TUBING & HOSE

Flexible Metal Hose
Adv. p 46 contains data on CMH flexible metal hose. Chicago Metal Hose Div., Flexonics Corp.

Flexible Metallic Tubing **541**
Illustrated folder "Flexineering" contains data on Penflex tubing. Pennsylvania Flexible Metallic Tubing Co., Inc. p 40.

Pipe Unions
Adv. p 123 contains information on Dart unions. Dart Union Company.

PUMPS

Wheeler-Economy Pumps
See adv. p 44 for data on Wheeler-Economy Pumps, C. H. Wheeler Mfg. Co.

Pumps **542**
Bull 202 contains complete data on steam driven pumps. American-Marsh Pumps, Inc. p 102.

Chemical Feeders & Hypochlorinators
Adv. p 119 gives data on chemical feeders and hypochlorinators in capacities of a drop to 60 gph. Manzel, Inc.

Pumps
Adv. p 109 contains information on Weinman pumps. The Weinman Pump Mfg. Co.

Pumps **543**
Bulletin gives full application and specification data on De Laval boiler feed pumps. De Laval Steam Turbine Co. p 39.

Pumps **544**
Condensed Catalog "M" contains information on Aurora pumps. Aurora Pump Co. p 139.

REFRACTORY CONCRETES

Refractory Cement **545**
Coupon p 118 offers catalog and prices on Super 3000 refractory cement. Refractory & Insulation Corp.

SOOT BLOWERS & TUBE CLEANERS

Tube Cleaners **546**
Full details available on Airetool tube cleaners with slip-fit construction. Airetool Mfg. Co. p 127.

Tube Expanders **547**
Bull 380A contains complete information on Wilson tube expanders. Thomas C. Wilson, Inc. p 140.

STEAM SPECIALTIES

Impulse Steam Traps **548**
24-page catalog contains data on Yarway traps and strainers. Yarnall-Waring Co. p 64.

Steam Traps **549**
Coupon offers book "Solving Steam Trap Problems." The V. D. Anderson Co. p 142.

Snap-On Tools **550**
Snap-On Boxockets are described in the industrial and general catalog of 4,000 tools for production and maintenance. Snap-On Tools Corp. p 130.

Traps **551**
Bull 145-A contains complete data on Sarco steam traps. Sarco Co., Inc. p 18.

Traps **552**
Cat 68-H describes inverted, open bucket and other types of Strong traps. Strong, Carlisle & Hammond Co. p 110.

Illinois Steam Traps **553**
Bull 35 contains data on Illinois steam traps. Illinois Engineering Co. p 125.

THERMAL INSULATION

Insulating Cement **554**
Coupon on p 112 contains complete data on Black Rockwell insulating materials. Baldwin-Hill Co.

Heat Insulation **556**
Free book available on "Kaylo Heat Insulation." Owens-Illinois Glass Co., Kaylo Div. p 41.

TOOLS

Masonry & Concrete Saws **557**
Adv. p 122 contains coupon for free literature on masonry and concrete saws. Clipper Mfg. Co.

TURBINES

Turbines
Adv. p 27 contains data on Worthington steam turbines. Worthington Corp., Steam Turbine Div.

Turbines **558**
Bull S-116 contains information on the Terry Solid-Wheel turbine. The Terry Steam Turbine Co. p 55.

VALVES

Check Valves **559**
Catalog 30 contains complete information on Chapman tilting disc check valves. Chapman Valve Mfg. Co. p 50.

Blow-Off Valves **560**
Bulletin describes boiler blow-off valves. Everlasting Valve Co. p 121.

Pump Valves **561**
Catalog gives 4 ways to cut pump repairs. Sims Pump Valve Co., Inc. p 125.

Blow-Off Valves **562**
Bulletins B-424 and B-433 contain data on Yarway blow-off valves. Yarnall-Waring Co. p 30, 31.

Butterfly Valves **563**
Valve catalog contains data on Rockwell butterfly valves. W. S. Rockwell Co. p 133.

Valves
See adv. p 7 for information on Crane valves. Crane Co.

Solenoid Valves
Adv. p 135 contains data on Davis line of solenoid valves. Davis Regulator Co.

WATER TREATMENT

Water Conditioning
Adv. p 58 contains information on Elgin water conditioning systems for every need. Elgin Softener Corp.

Water Conditioning Service **564**
Technical Paper No. 115, "Carryover Prevention with Anti-Foam Agents." W. H. & L. D. Betz. p 17.

Water Conditioning Systems **565**
Bull W-212-B5 contains facts on Worthington cold process water softening method. Worthington Corp., Water Treating Section. p 34.

Water Treatment **566**
Adv. p 29 offers data on dealkalization with Amberlite IRA-410. Rohm & Haas Co.

Water Treatment
Adv. p 13 contains data on the Nalco system of water treatment. National Aluminate Corp.

Water Treatment Plants **567**
Bulletins are available on manual and automatic water treatment plants. Hungerford & Terry, Inc. p 138.

Dealkalization Process **568**
Complete details available on new process for softening and dealkalizing water. American Water Softener Co. p 129.

These EVERLASTING advantages give better service from

Fig. 4001/6561. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Angle Blowing Valve.

BOILER BLOW-OFF VALVES

When you install an EVERLASTING Duplex Blow-Off Unit, you'll find that its many superiorities speak for themselves.

The sealing valve at the left is the EVERLASTING design that has been famous for more than 40 years . . . the valve with the drop-tight seal that actually improves with use because of its self-lapping action each time the valve is opened or closed . . . the valve that can't stick or jam because of its non-wedge design . . . the valve that opens in less than a quarter turn to provide unimpeded straight-through blow.

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Each of these valves . . . and all the other EVERLASTING Boiler Blow-Off valve types, fully meet ASME code requirements . . . assurance that they are properly designed and amply strong for the service.

Fig. 4001/6571. Duplex unit consisting of Straightway Lever-operated Sealing Valve and Y Blowing Valve.

Fig. 6571/6561. Duplex unit consisting of Y Sealing Valve and Angle Blowing Valve.

Fig. 6561/6571. Duplex unit consisting of Angle Sealing Valve and Y Blowing Valve.

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A NEW CLIPPER PAYS FOR ITSELF* on a SINGLE FURNACE or BOILER RELINE JOB!

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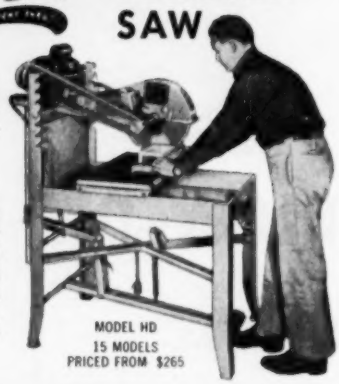

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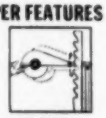

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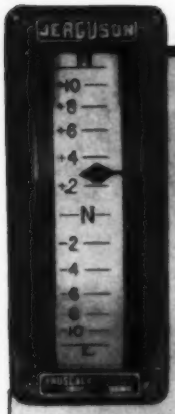

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DART

WESTON TAG

Thermometers

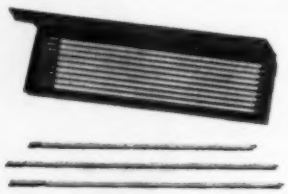
in all forms—ranges—stem lengths—connections

Whether your requirement calls for certified laboratory thermometers . . . or rugged all-metal industrial types . . . or thermometers for remote reading . . . you'll find *exactly* what you require in the Weston-TAG line—*the most comprehensive line of quality thermometers ever offered by ONE manufacturer.* Literature on request. WESTON Electrical Instrument Corporation, 617 Frelinghuysen Avenue, Newark 5, New Jersey.

Laboratory

ALL-METAL

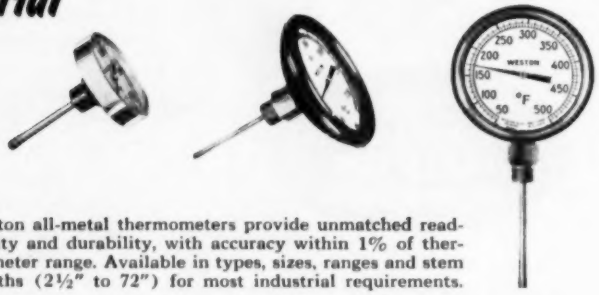
—have readable, dial-type scales and corrosion-resisting stainless steel stems—stem lengths from 2" to 24"—ranges from low as −100°F. to high as 1000°F.—accuracy ½ of 1% of thermometer range.



GLASS

—certified sets of ASTM Testing thermometers with overlapping ranges in protective case. Ranges from −36°F. to high as 760°F. Also precision and standard etched stem thermometers for general testing.

Industrial

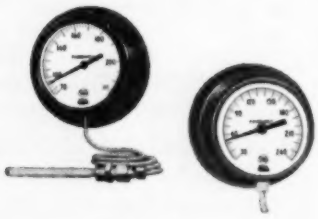


Weston all-metal thermometers provide unmatched readability and durability, with accuracy within 1% of thermometer range. Available in types, sizes, ranges and stem lengths (2½" to 72") for most industrial requirements.

Remote Reading

ELECTRICAL

—resistor bulb sensing element permits mounting indicator any distance away from point of measurement. *Multiple* remote readings also possible by use of selector switch and several bulbs.



PRESSURE ACTUATED

—for remote reading, in 5, 6 and 8" dial sizes. Ranges from low as −325°F. to high as 1000°F. Accuracy one scale division unaffected by vibration or severe shock. Cases of iron, brass, or plastic.

WESTON *Temperature Instruments*

9413

Reviews of recent books . .

Write to the publisher for books in which you are interested

Electrical Code Diagrams

"Electrical Code Diagrams," Volumes 1 and 2, by B. Z. Segall. Published by McGraw-Hill Book Co., 330 West 42nd St., New York 36, N. Y. 780 and 907 pages respectively; illustrated; price $12.50 each volume.

Exact meanings and requirements of the 1951 National Electrical Code are clarified by these books. One or more diagrams for each Code rule are presented to show exactly how each may be applied. Background engineering information and electrical theory, together with explanations of why certain rules are part of the Code and what purpose they serve, are presented.

Volume 1 covers two chapters of the Code: chapter 2, Wiring Design and Protection; and chapter 3, Wiring Methods and Materials. Volume 2 covers chapters 4 to 8, entitled: Equipment for General Use; Special Occupancies; Special Equipment; Electrical Code Diagrams; and Communication Circuits and Radio Equipment.

Meetings and exhibitions

FEBRUARY

Second Annual Industrial Ventilation Conference, developed cooperatively by the Michigan Department of Health and the School of Engineering, Michigan State College, for engineers concerned with the design of exhaust and ventilation systems. The program will be held at the MSC campus, East Lansing, Mich., Feb 16-19.

Instrument Society of America will hold its sixth annual Regional Meeting at the Hotel Statler, New York, Feb. 18.

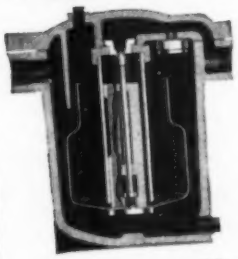
Industry Conference on Air Pollution Abatement, sponsored by Manufacturing Chemists' Association, Inc., will take place in the Hotel Statler, Detroit, Mich., Feb. 26-27.

MARCH

National Association of Corrosion Engineers will hold its Chemical Industry Symposium at the Hotel Sherman, Chicago, March 16-20.

National Power Show, sponsored by National Association of Power Engineers, will be held at the Hotel Sherman, Chicago, March 24-27.

ILLINOIS Steam Trap



Simple—has only two moving parts

Valve Stem Travels Independent of Bucket—no other trap has this feature.

Instantaneous Valve Action — either wide open or tight shut — will not dribble on partial closing of valve under slow condensation rates.

Wire Drawing Impossible — valve has snap action.

Simple — moving parts are valve and bucket.

Cannot Air Bind — vents air continuously without loss of steam.

Cannot Blow Steam — always water sealed.

Surface Discharge—flushes out all grease and sludge.

Valve Seat — of special alloy, fully guaranteed.

Inspection Easy — without disturbing piping.

Works Equally Well on All Fluids — compressed air lines, air separators, air aftercoolers.

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with a

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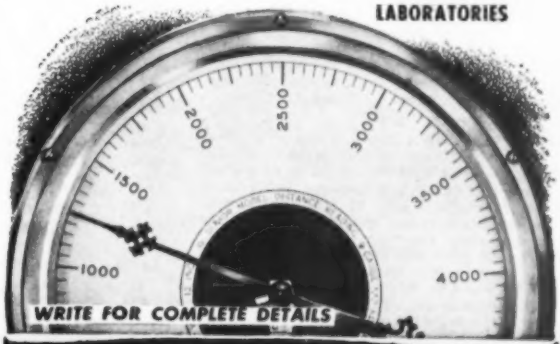
- 100% AUTOMATIC
- APPROVED BY UNDERWRITERS' LABORATORIES



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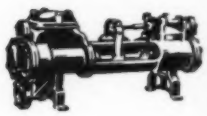
36-32 SKILLMAN AVE., LONG ISLAND CITY, N.Y.



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Worn, leaky pump valves are the cause of frequent repairs. Replace them with Sims Pump Valves — you'll get guaranteed better performance.

These four features combine to give you longer service with Sims valves:

1. Exclusive double shock-absorber stem heads eliminate stem breakage.
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REPAIR CONCRETE WITH INSTANT-SETTING PATCH

Patch broken factory floors without the usual traffic tie-up. Simply shovel INSTANT-USE into the hole or rut — tamp smooth — truck over! No waiting! INSTANT-USE bonds tight to old concrete — right up to a feather edge. It's tough. Wears like iron. Won't crack or crumble. Install complete overlay where floors are badly chewed up. Used indoors or out. Immediate shipment.

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Please send me complete INSTANT-USE information, details of TRIAL ORDER PLAN and HAND BOOK OF BUILDING MAINTENANCE — no obligation. (Clip and attach Coupon to Co. letterhead).

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New bulletins and catalogs

Literature on engineering products and developments

Each new bulletin item has a key number for your convenience in asking for a free, personal copy. Insert key numbers on return post card found on page 115

AIR & DUST FILTERS & COLLECTORS

Electrode Rapping System **200**

Discussed in 6-page folder M1 is the theory of operation for a recently developed magnetic impulse, continuous, intensity controlled rapping system for electrostatic precipitators. Major components and features are summarized. Research Corp.

Dust Collection **201**

Five basic types of dust control equipment, designed to meet the needs of a wide variety of industries, are the subject of 40-page brochure 800. In addition to discussing features of design, construction and operation, the booklet also lists advantages and specifications for each basic type. Accessories such as fans, vibrators and valves also are presented. Technical information is presented to aid the engineer in solving dust collection problems. A table lists air volume and resistance at common velocities. Dracco Corp.

ANTI-CORROSIVE & PROTECTIVE COATINGS

Rust Preventative Coatings **202**

Complete instructions for surface preparation and application of rust preventive coatings are given in 16-page general catalog. Many important facts also are brought out in a question and answer section. Color chips are given for primers, short oil types, long oil types, machinery and implement finishes, chemical and heat resistant types, sealers, thinning oils, and floor and masonry coatings. Rust-Oleum Corp.

BOILERS & BOILER ACCESSORIES

Boiler Control **203**

How a system of boiler control and instrumentation operates is shown in three diagrams contained in 10-page bulletin 1007. Descriptions are given for each component part, including combustion, feed water, boiler steam temperature and soot blower controls. Instrumentation includes standard and miniature units with conventional, console or graphic panels. Copes-Vulcan Div., Continental Foundry & Machine Co.

Steam Gage Illuminators **205**

Mercury vapor illuminators for steam gages are the subject of data sheet 196. Unmistakable water level indication is provided by a brilliant green spot at the water level. How it is installed on standard gages is discussed. Jerguson Gage & Valve Co.

CONTROLS, REGULATORS & INSTRUMENTS

Level Control **206**

Outstanding features of an electronic level control are summarized in 8-page brochure F-101. Applications, specifications and installation are described. Standard electrodes and cables also are discussed. Fielden Instrument Div., Robertshaw-Fulton Controls Co.

Transducers **207**

According to 12-page bulletin 15-16, consumption of electric power in certain process operations is the only measurable or isolable variable. The application of power measurement transducers to such processes is described, and technical data on a few examples are given. Applications of thermal converters, solenoid-plunger ammeter, torquemeter, vacuum thermocouple, rectifying current system, precision shunt, saturable reactor and magnetic amplifier are covered. Diagrams, tables of characteristics and mathematical formulas are supplied. Brown Instruments Div., Minneapolis-Honeywell Regulator Co.

Venturi Nozzle **208**

Discussed in bulletin 130-J6 is a plastic lined venturi nozzle designed for corrosive liquids. The literature describes it as a flanged type differential producer without piezometer rings. Corrosive liquids that can be metered are listed, and a ratio chart and capacity table for obtaining capacities of liquids other than water are presented. Builders-Providence Inc.

Control Panels **209**

Engineering and planning of combustion and process control panels is discussed in 8-page bulletin 170. Numerous panel designs are discussed, along with the most up-to-date methods of tubing and wiring. A section on panel accessories serves to make a valuable source book of ideas for control station planners. Bailey Meter Co.

Pneumatic Operator **210**

Accurate, high speed positioning and regulating of heavy equipment is provided by a pneumatic positioning operator described in 4-page folder S-15. Cross-section views show construction and operation. Republic Flow Meters Co.

ELECTRICAL DISTRIBUTION

Power Conversion Units **211**

Metallic rectifier power conversion units are the subject of 8-page bulletin GEA-5658B. Design features, performance, circuits, applications and advantages are discussed. A chart of dimensions, ratings and weights is included. General Electric Co.

Control Centers **212**

"Why a control center?" In answering this question, 32-page booklet B-5621 discusses characteristics that make for flexibility of application, ease of servicing, and safety of operating personnel. Three types of control centers together with various

(Continued on page 128)

PRODUCT INDEX

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Transformers 134
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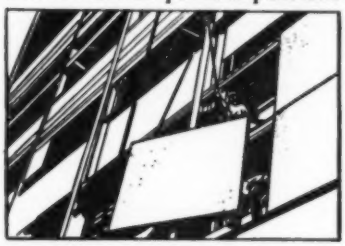
External House Organs 135

Belt Conveyer Handbook **204**

Complete information on the latest designs and engineering data required to design a belt conveyer for any application are presented in 86-page catalog 852. The booklet states that many problems can be answered by using a standardized conveyer unit. These units have been indexed and classified to simplify the determination of the correct conveyer for a specific application. In addition, anti-friction idlers to meet any service requirement, whether temporary or permanent, are listed. For quick reference, descriptions and data also are presented on such equipment as belting, trippers, terminal pulleys, take-ups, and backstops. The Jeffrey Manufacturing Co.

Marietta Concrete Wall Panels save 30% of new building costs

A revolutionary new development in precast insulated concrete wall panels is currently saving a large industrial firm as much as 30% on the construction of its new, multi-million dollar plant expansion.



These panels are designed for quick erection of curtain walls. A nine man crew is erecting 3,500 sq. ft. of finished wall in a day. The panels are made of high strength concrete and are cast solid, or cast with concrete facing and rigid insulation core. Marietta engineers report that tests show these panels have compression strengths over 4,000 psi. and an insulating U-value of 0.14, surpassing the usual 12-inch masonry wall in both these properties. Panels are cast in modular sizes to meet every building requirement. Full details and engineering service are available by writing to The Marietta Concrete Corporation.

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Marietta concrete industrial storage systems are being used by a wide variety of leading industries for safe, permanent, low-cost storage and materials handling facilities. These concrete stave silos are available in any size, any arrangement to meet present and future storage requirements. They're designed for labor-saving, large capacity, efficient storage and will protect stored bulk raw materials from fire, moisture, air and acids at low cost. A complete Marietta storage system, including necessary materials handling equipment, can be designed and quickly erected to solve your storage needs. Write for full details.

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One of many reasons why skilled industrial maintenance workmen prefer
AIRETOOL TUBE CLEANERS

slip-fit construction

Each part of an AIRETOOL tube cleaner motor is made of heat treated alloy steel, precision ground to a perfect slip-fit. The operator can take the motor apart when necessary and quickly reassemble it right on the job without special tools. This convenience reduces down-time, makes maintenance easy. It is one of many basic, work-saving reasons why maintenance men specify AIRETOOL for fast, efficient cleaning of all types of industrial tubes, straight or curved. For full details write The AIRETOOL Mfg., Co., 318 S. Center St., Springfield, Ohio.

AIRETOOL boiler tube cleaner for thoroughly cleaning curved tubes with short radius.

There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction.

SLIP-FIT CONSTRUCTED MOTORS—5-blade, 2-stage construction, each stage with double exhaust. Five lubrication points.

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MORE ENGINEERING
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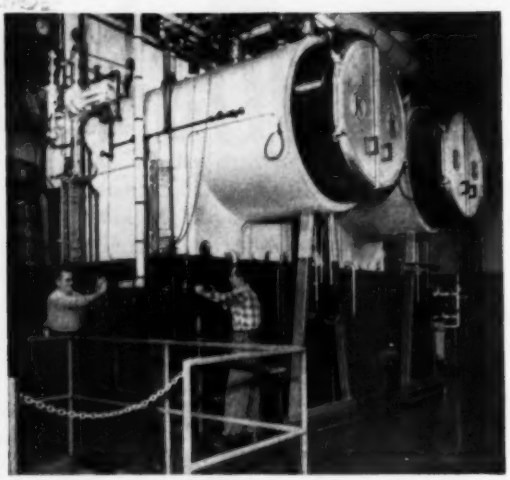

KEWANEE
STEEL BOILERS

Set a Kewanee alongside other boilers and even a quick look shows their extra ruggedness, finely finished castings and other evidences of a high quality product. Then look inside! Check the specifications, measurements, size of fire chamber, area of heating surface and one finds many other differences. More engineering, more material, more labor and more experience go into every Kewanee . . . whether for heating, power or process steam . . . so owners get more from them.

With experienced engineers and mechanics on their staff, a great air line knows mechanical equipment. So it means much when concerns such as Northwest Air Lines install Kewanee Boilers in an important building.

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International Airport
Seattle-Tacoma, Wash.
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AUSTIN COMPANY
2 Kewanee Heavy-Duty Boilers,
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KEWANEE-ROSS CORPORATION
Division of American Radiator & Standard Sanitary Corporation
KEWANEE, ILLINOIS

New bulletins and catalogs

(Continued from page 126)

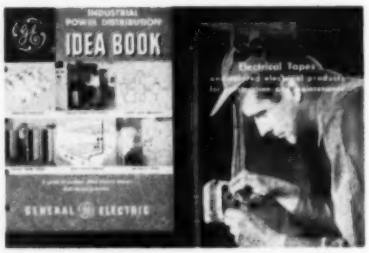
electrical components are described. Information is included to aid in selecting the right control center arrangement and the starter size. Westinghouse Electric Corp.

Enclosed Switch **213**

Construction features and advantages of a recently developed heavy duty metal enclosed switch, said to combine the functions of disconnect and load interrupter, are given in 4-page folder 5208. Units are for 600 v, a-c or d-c service. A table lists 2 and 3 pole models, with or without provisions for fuses, for 400 to 3000 amp ratings. Delta-Star Electric Co.

Distribution Practices **214**

"Industrial Power Distribution Idea Book," 28-page booklet GEA-5900, has been published as a guide on distribution practices in large and small plants. A few of the topics discussed are: what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; types of load-center distribution systems; use of branch feeder switches, starters and fuses; grounding of systems; how to calculate interrupting capacity; how to apply capacitors; and methods of obtaining economical d-c supply. General Electric Co.



ELECTRICAL INSULATION

Electrical Tapes **215**

Specifications for electrical tapes and related electrical products for construction and maintenance are given in 12-page brochure E-CMBR (1221) LP. Descriptions are given for plastic tapes, glass cloth tape with thermosetting adhesive, and insulation putty in tape form. Electrical spring connectors and a coating also are discussed. Minnesota Mining & Mfg. Co.

DIESELS

Diesel Engine **216**

Smaller and lighter, but for heavy-duty service, is the description of a diesel engine discussed in 12-page bulletin 10027. Three models are listed, ranging from 200 to 380 hp at 900 to 1000 rpm. Specifications, weights, performance curves and dimensions are included. Ingersoll-Rand Co.

ELECTRICAL HEATING UNITS

Electric Comfort Heaters **217**

Listed in 8-page catalog D-52 are 75 different models of forced air, convection and radiant heaters in capacities of ¼ to 100 kw. Information is presented to aid in selecting the proper unit for any particular job. A quick selector chart shows how

to calculate heat requirements for given areas and types of building construction. Edwin L. Wiegand Co.

FILTERS, STRAINERS & PURIFIERS

Purifiers **218**

Published to acquaint engineers with facts concerning purifiers, 8-page bulletin 700 discusses units for removal of entrainment in live steam, exhaust steam, vapors and compressed gases. Diagrams illustrate how different types are used to perform various functions. V. D. Anderson Co.

HEAT EXCHANGER EQUIPMENT

Heat Exchangers **219**

Various types of heat transfer equipment are among the products described in 12-page catalog 12. Also presented are various types of dry blending equipment and such process equipment as kettles, evaporators, vessels, reactors and coils. The Patterson-Kelley Co., Inc.

HOW TO REQUEST FREE BULLETIN

Insert "key" numbers on return post card found on page 115. Our Reader's Service Department will handle your request promptly

---

Water Heaters & Coolers **220**

Drawings contained in an 8-page brochure show a wide variety of water heaters and coolers. Diagrams are used to explain how each individual unit functions. In addition to product descriptions, the literature contains useful tables dealing with heater selection, sizes and capacities. Manning & Lewis Engineering Co.

LUBRICANTS, LUBRICATION, OIL FILTERS & PURIFIERS

Lubricant **221**

High load-carrying ability, non-corrosive qualities and longer lubricating life are advantages listed for an extreme-pressure lubricant described in 12-page booklet A-2612. The new lubricant, developed primarily for high-output industrial gearing, is also recommended for heavily loaded plain bearings and screws. Lubricating problems caused by stepping up production with existing equipment are outlined, together with recommendations. Sun Oil Co.

Graphite Lubricant **222**

Advantages of colloidal graphite as a high-temperature lubricant are outlined in 4-page folder 423. How it is used and recommendations for specific lubrication problems are given, together with case studies. Acheson Colloids Co.

MOTORS & GENERATORS

Thyraton Motor Controls **223**

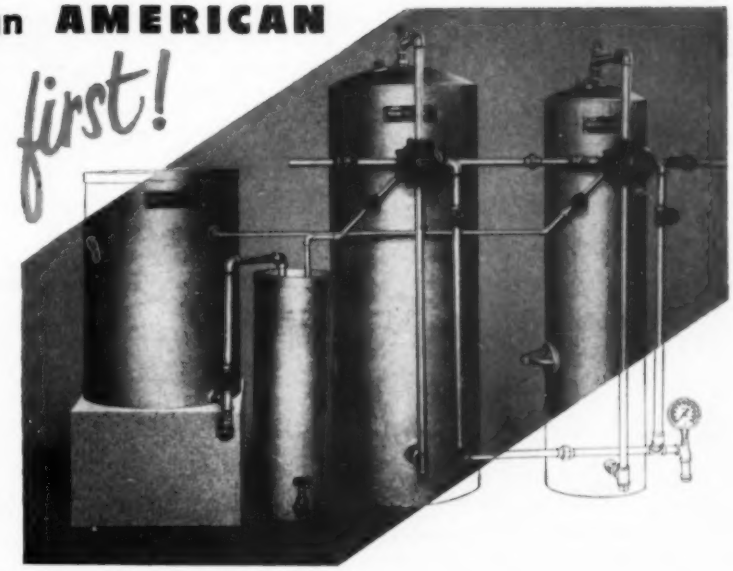
How thyraton motor controls provide the stepless speed control of a d-c motor from a-c power is explained in 4-page folder GEA-5827. Component parts, operation and specifications of a precision controlled packaged drive for ¾ to 10 hp applications are discussed. General Electric Co.

Totally-Enclosed Motors **224**

Totally-enclosed and explosion proof motors, safe for dangerous, damp and rusty locations, are the subject of 8-page brochure F1784. Design features, advantages, installations and applications are described. U. S. Electrical Motors, Inc.

(Continued on page 130)

an **AMERICAN** *first!*



a simple, safe DEALKALIZATION PROCESS *saves you up to 33%!*

AMERICAN'S New Process for alkalinity reduction by chloride anion exchange operates without the use of acid and increases the capacity of anion exchange resins from 33% to 50%, resulting in a saving to the user of up to 33%.

The exchange resins remove all bicarbonates and other anions from the water solution, replacing them with chlorides. When common salt alone is used as the regenerant, the exchange capacity of the resin is extremely low because blanketing gases are formed which prevent complete regeneration of the resin bed.

AMERICAN engineers successfully solved this change by proving that increasing the pH of the regenerant solution eliminated this tendency toward gas blanketing . . . The admixture of a small amount of sodium hydroxide to the brine regenerant is an *AMERICAN development which not only increases the capacity of the resin but also greatly improves the quality of the effluent.

Specific advantages of the AMERICAN Process over conventional methods are:

1. *Up to 50% increase in capacity with no increase in regenerant dosage.*
2. *A dramatically improved effluent quality.*
3. *Non-corrosive effluent—high pH.*
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AMERICAN engineers are specialists in solving water-conditioning problems. Why not get in touch with them? Write or phone today for full details of this new process.

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on job after job...
YOU'LL FIND
*Snap-on
BOXOCKETS
the handiest, safest, fastest wrenches you have ever used

Put *speed* on the job . . . with Snap-on Boxockets . . . far stronger and many times safer than open end or adjustable wrenches! Offset heads provide ample clearance in tight places. Double hexagon openings completely encircle the nut—grip securely on all six corners—cannot slip—cannot spread—and require only half the turning space where movement is limited. Each Boxocket provides two wrench sizes in each handle. Complete series covers full range of sizes, 3/8" to 1 5/8". Other types—Midget, Dwarf, Heavy Duty and Sledge—3/16" to 4 3/8". Write for Industrial Catalog and General Catalog of 4,000 Snap-on tools for production and maintenance.

XV-611-K OFFSET BOXOCKET SET—Consists of 11 wrenches, range 3/8" to 1 1/4", in handy kit bag. Provides 22 wrench sizes with six popular sizes duplicated.

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8102-B 28th Ave. • Kenosha, Wisconsin

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New bulletins and catalogs

(Continued from page 129)

MECHANICAL POWER TRANSMISSION

Power Transmission **225**

Descriptions of power transmission equipment are featured in 36-page catalog R-103-A. Listed are such products as V-belts, detachable link V-belting, pulleys, sheaves, roller chain, belt lacing and speed reducers. Useful engineering data are outlined in charts and diagrams. Rockwood Pulley Manufacturing Co., Inc.

Helical Gear Drives **226**

Advantages of helical gear drives are discussed in 16-page booklet 2451. Cross-sectional views show design and construction features of double and triple reduction types, and photos picture typical installations. Factors governing selection are described in detail. Tables list horsepower ratings, ratios and input speeds for units from fractional to over 100 hp and ratios to approximately 300:1. Load classes for 170 types of machines are listed alphabetically. Link-Belt Co.

V-Belts **227**

Construction features of multiple and light duty V-belts are summarized in 8-page bulletin 3787. Tables list specifications and conversion tables explain identification systems of various manufacturers to aid in belt replacement. Thermoid Co.

Disc Brakes **228**

Airplane-type disc brakes for industrial uses are the subject of 8-page bulletin A 1725 K. In addition to pointing out the advantages of employing single disc brakes, the booklet also describes a few of the varied industrial applications. Industrial Brake Dept., Aviation Products Div., Goodyear Tire & Rubber Co.

FANS & BLOWERS

Centrifugal Blowers **229**

Descriptive material on centrifugal blowers, recently added to the list of air moving equipment manufactured by this company, is included in 24-page catalog B-10. Dimension drawings and complete air delivery tables are given for each model. Hartzell Propeller Fan Co.

PIPE, TUBING & HOSE

Flexible Tubing **230**

Several types of flexible tubing for ventilation, fume and dust removal, and materials handling are described in 8-page bulletin C2-4. Construction and advantages are discussed. A chart shows at a glance which type of tubing is best suited for each of a long list of industrial applications. Engineering data are given, including an air friction chart and a specifications table. Flexible Tubing Corp.

Air Hose **231**

Five grades of air hose, described as having tough, oilproof covers to prevent peeling, are featured in 4-page folder 3460. Specifications, materials and methods used in construction are described together with recommended uses for the various types. B. F. Goodrich Chemical Co.

Swing Joints **232**

Ball bearing equipped swing joints for use on lines handling oil, gasoline, chemicals and other liquids are described in 8-page brochure 400. Construction features, specifications and dimensions are presented. Other products such as ball, revolving and swivel joints also are listed. Barco Manufacturing Co.

Welded Steel Pipe **233**

Data contained in 42-page reference manual 3M should be of value to all pipe users. Tabulated in this booklet is information on fittings, field joints, protective coatings and types of fusion welded steel pipe for water, oil or gas from 4 to 36 in. diam. Such engineering data as a flow chart and tables of safe working pressures add to the publication's value. Southern Pipe & Casing Co.

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Insulated Pipe **234**

Applications for pre-sealed insulated pipe, described in 4-page folder 6C, include underground and weather exposed piping systems conveying hot or cold liquids, gases and steam up to 1000 psi. The bulletin gives applications, special features, construction, fabrication and specifications. Durant Insulated Pipe Co.

Plastic Pipe Data **235**

Data on head loss due to friction in plastic pipe are given in the form of charts and graphs. A graph of water flow vs head loss for both plastic and steel pipe gives a comparison of flow characteristics. Carlon Products Corp.

PACKINGS & GASKETS

Mechanical Packing **236**

Included in 20-page catalog PC-102 is an application chart which provides a quick and accurate means of determining the proper packing for a specific service condition. Data, structure and performance of self-lubricating, molded, sheet and Teflon types are presented. Greene, Tweed & Co.

REFRACTORIES

Insulated Walls **237**

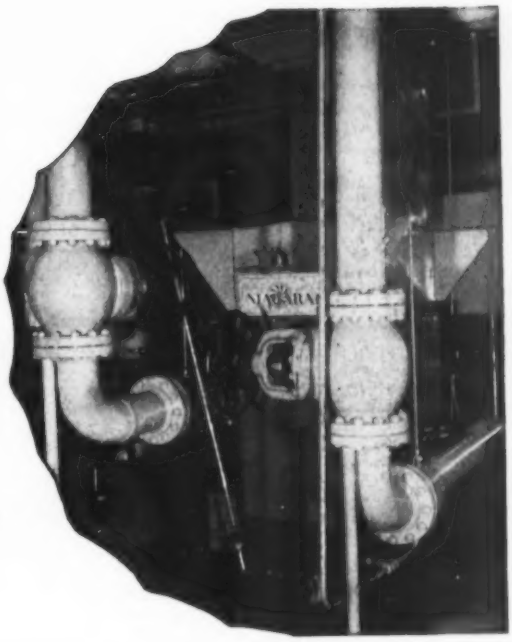
Thin wall construction for industrial furnace enclosures is described in a 12-page bulletin. Photos and engineering drawings show the thin, insulated walls as used for boilers, refinery heaters, dryer furnaces and kilns. Bigelow-Liptak Corp.

Water Wall Tile **238**

Thin refractory tile construction for water wall backing and boiler baffles is described in 8-page bulletin 44. Engineering information shows how tile are installed and presents charts and graphs of heat losses and physical characteristics. Recommendations for the design of tie backs also are given. Laclede-Christy Co.

(Continued on page 132)

How to get drier or cooler air or gases . . .



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New bulletins and catalogs

(Continued from page 131)

PUMPS

Industrial Pumps **239**

Included in 96-page catalog I-52 are descriptions of a wide variety of industrial pumps. Among the basic types represented are many models of centrifugal, vertical turbine, rotary, piston and reciprocating units. Selection tables and data of interest to pump users are presented. An illustrated table of contents provides a means of quick reference. The Deming Co.

Close-Coupled Pumps **240**

Construction features of supporting adapter type, close-coupled general purpose pumps are described in 6-page folder 52B6083A. Units have capacities to 2500 gpm at heads to 550 ft. Alternate sealing arrangements are discussed, and principle dimensions are listed. Allis-Chalmers Manufacturing Co.

Reciprocating Pumps **241**

Installation, operation and maintenance of reciprocating pumps is the subject of 20-page service manual 202. Useful conversion tables, technical data and general engineering information also are presented. Warren Steam Pump Co., Inc.

Vertical Pumps **242**

"Vertical Pumps for Volatile Fluids," 6-page folder 1026, describes the advantages of vertical turbine pumps for handling such liquids as gasoline, diesel fuel, crude oil, L-P gases, and ammonia. The mechanical features of several models are shown. Efficiency curves are included in the engineering data. Johnston Pump Co.

THERMAL INSULATION

Fire-Retardant Mastic **243**

Fire-retardant mastic for use in conjunction with thermal insulation to reduce the fire hazard of exploding gas and eliminate the need to bury tanks, is described in a data sheet. The product, for trowel or rubber-glove application, is described as providing good heat resistance over insulated pipes, vessels and equipment. A typical specification indicates how it is used. Benjamin Foster Co.

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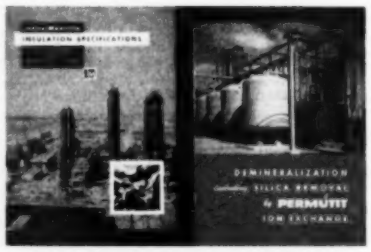
Insulation Specifications **244**

Engineers who must specify thermal insulations in oil refineries and chemical process plants should find a useful source of quick reference in 52-page brochure IN-128A. Specifications are listed for thermal insulations on various types of equipment. Seven tables list recommendations for thickness. Also described is a complete service, including materials, engineering and application. Johns-Manville.



WATER TREATMENT

Ion Exchange **245**

"Demineralization Including Silica Removal by Ion Exchange," 28-page booklet 3803, has been prepared to help explain one of the newer roles that ion exchangers are playing in industry. Described are applications, principles of operation, design features, advantages, recommendations, and specifications for demineralizing and silica removal apparatus and synthetic resins. The Permutit Co.

Distilling Plants **246**

Industrial applications for vertical basket type sea water distilling plants are suggested in an 8-page bulletin. Types of evaporators are discussed, together with such topics as the problem of scale, simplicity of operation and purity of the final product. Flow charts and diagrams are presented. The Maxim Silencer Co.

Marine Demineralizers **247**

Technical bulletin sheet 015 describes a demineralizer designed specifically for use on such marine vessels as barges, ferries and tugs. In addition to a discussion of advantages, a description of the construction and a table of specifications are given. Penfield Manufacturing Co., Inc.

(Continued on page 134)

24-HOUR PROTECTION

New Norgren Automatic-Drain Filter

AUTOMATICALLY **cleans the air**

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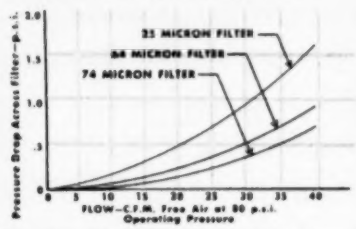

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New bulletins and catalogs

(Continued from page 132)

Deaerating Heaters **248**

Discussed in a report entitled "Experiences With Applications of Deaerating Heaters in Feedwater Cycles," are many different methods of adapting such equipment to a wide range of conditions. Actual experiences in determining the most suitable size, type and design of heater for various plants are included. Flow charts, diagrams of selected designs and tabulations of results are employed. General explanations of the various types of equipment and their characteristics also are given. Graver Water Conditioning Co.

TRANSFORMERS

Instrument Transformers **249**

"Instrument-Transformer Accuracy Standards," 16-page bulletin GET-1366A, is published to facilitate selection of proper instrument transformers for any particular application. The booklet lists accuracy standards for potential, metering current and relaying current types. Diagrams show graphical equivalents of American Standards Association accuracy classes. General Electric Co.

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STEAM SPECIALTIES

Impulse Steam Traps **250**

Construction and advantages of high capacity impulse steam traps are described in 4-page folder T-1745. Units are listed for maximum continuous discharge up to 37,400 lb per hr of condensate. Dimensions and materials of construction also are presented. Yarnall-Waring Co.

Industrial Steam Trap **251**

Features of construction and operation of small size industrial steam traps, from ¼ to ¾ in., are given in data sheet 351. Applications are suggested. Tables list dimensions and capacities at various pressures. W. H. Nicholson & Co.

Compound Steam Traps **252**

Piston-operated compound steam traps for draining equipment producing large amounts of condensate, such as purifiers, separators, evaporators, and desuperheaters, are discussed in 8-page bulletin 215. In addition to describing the construction and listing physical data, such details as how they work, operation and installation are covered. Armstrong Machine Works.

VALVES

Control Valves **253**

Advantages of air power for high production equipment are summarized in 12-page brochure 101A. Integral pilot operated, remote controlled and direct operated control valves are described. Advantages, operation and available models of each are discussed. Cutaway views indicate air flow through the units. Ross Operating Valve Co.

Needle Valves 254

Specifications and dimensions of recently developed gland-type needle valves are tabulated in 4-page folder 568. Included in a list of applications are gages, by-passes, and fine regulation of gases and liquids. A wide selection of models are discussed. The Lunkenheimer Co.

Regulating Valves 255

Specifications for internal pilot regulating valves for on-off control are contained in 4-page specification sheet 404-1. Details of construction for slip stem and rotary shaft types are shown. Engineering data and mounting dimensions are tabulated. Industrial Div., Minneapolis - Honeywell Regulator Co.

Reviews of EXTERNAL HOUSE ORGANS

For a regular copy of a particular house organ, write direct to company

CEC Recordings

Instrumentation in a variety of industries is the theme of this 12-page quarterly house organ. Technical articles plus stories of actual installations are presented. A recent issue, Vol. 6, No. 4, presents such articles as: "Vibration Testing at U. S. Electric Motors," "Continuous Mass Spectrometry at ESSO," "Process Control by MS at Jefferson Chemical," "Fluor Corp. Prechecks Fans," and "AiResearch Monitors Vibration at 100,000 rpm." Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 15, Calif.

Nickelsworth

How nickel and nickel alloys have been used in a variety of applications is the subject of an 8-page publication. In a recent issue, articles pointed out how alloys were used in building construction, radiant tubes, machinery shafts, and various high temperature and corrosion resistant applications. Examples featuring the use of alloy welding rods also are given. The International Nickel Co., Inc., 67 Wall St., New York 5, N.Y.

The Firebox

Published by a manufacturer of refractory products, this 24-page quarterly house organ presents technical articles dealing with various types of refractories and their applications in such equipment as boilers, incinerators and industrial furnaces. Articles describing construction practices and the latest products are designed to keep the reader informed. Interesting non-technical stories add to the reading pleasure of the booklet. Plibrico Jointless Firebrick Co., 1800 Kingsbury St., Chicago 14, Ill.

ERRATA

Acknowledgment is made of an error in the article COAL CRUSHERS . . . Types and Classifications, page 84 of the January 1953 issue of INDUSTRY AND POWER. In the first paragraph, seventh line, the figure 60 should have been 33. This refers to the percentage of undersize coal passing through the screen.

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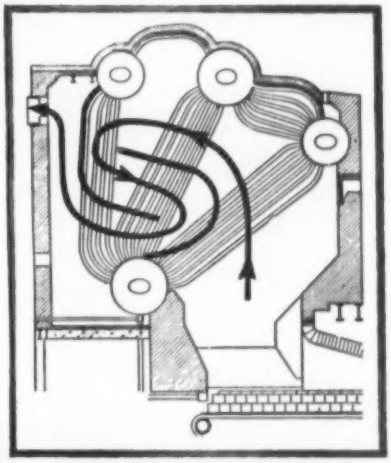

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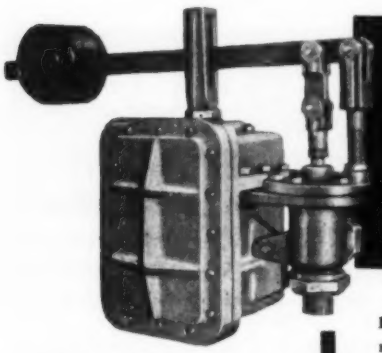

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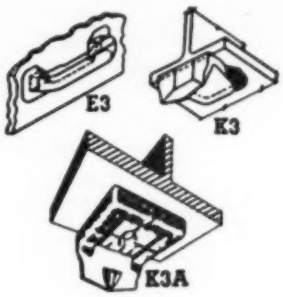

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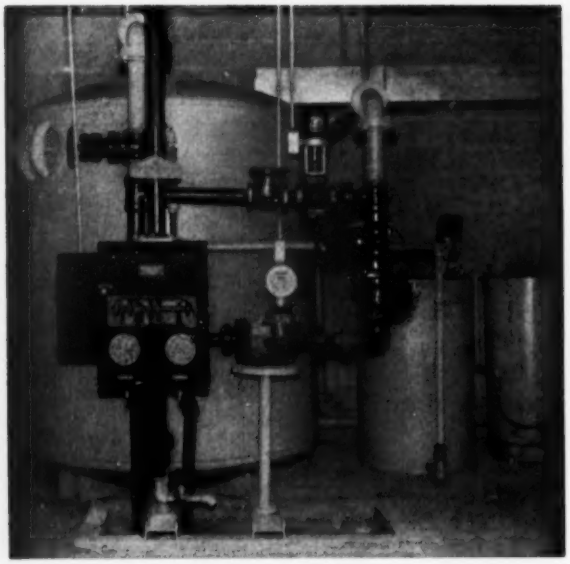

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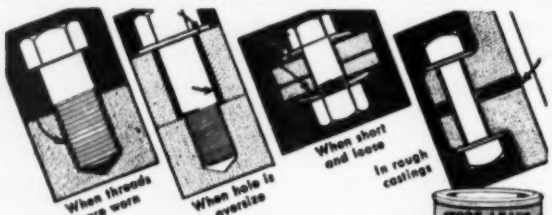

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Wilson Model 38 Tube Expander— Popular, parallel, expansion flaring and rolling tool for high pressure boiler tubes, superheaters, economizers and marine steam generators. They do both rolling and flaring in a single operation . . . are available for tubes 1" OD to 4½" OD with various rolled lengths for tube sheets a half inch and up in thickness. Write for Bulletin 380A.

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Cable address: "Tubeclean" New York

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standardize on standard

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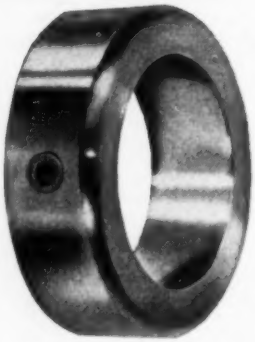
SOLID STEEL COLLARS



Buy standardized, precision-made HALLOWELL Steel Collars from your distributor's stocks. You'll save time and money by picking up the telephone and placing your order. Deliveries are prompt.

42 stock sizes—for shafts from 5/16" to 3" diameter, inclusive—all positively positioned on the shafts by UNBRAKO Self-Locking Socket Set Screws, the screws that won't work loose.

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HALLOWELL POWER TRANSMISSION DIVISION

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JENKINTOWN PENNSYLVANIA

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A good strainer eliminates this danger.

Armstrong strainers are good. They are made of cast semi-steel for maximum pressure of 250 psi—are available in ¼" to 2" sizes. Those with brass screens are stocked by Armstrong representatives. Stainless steel screens are available on order.

For Steam, Air, Gas, Water and Oil Lines. Get prices and more data on this good strainer. Write for Bulletin 184.

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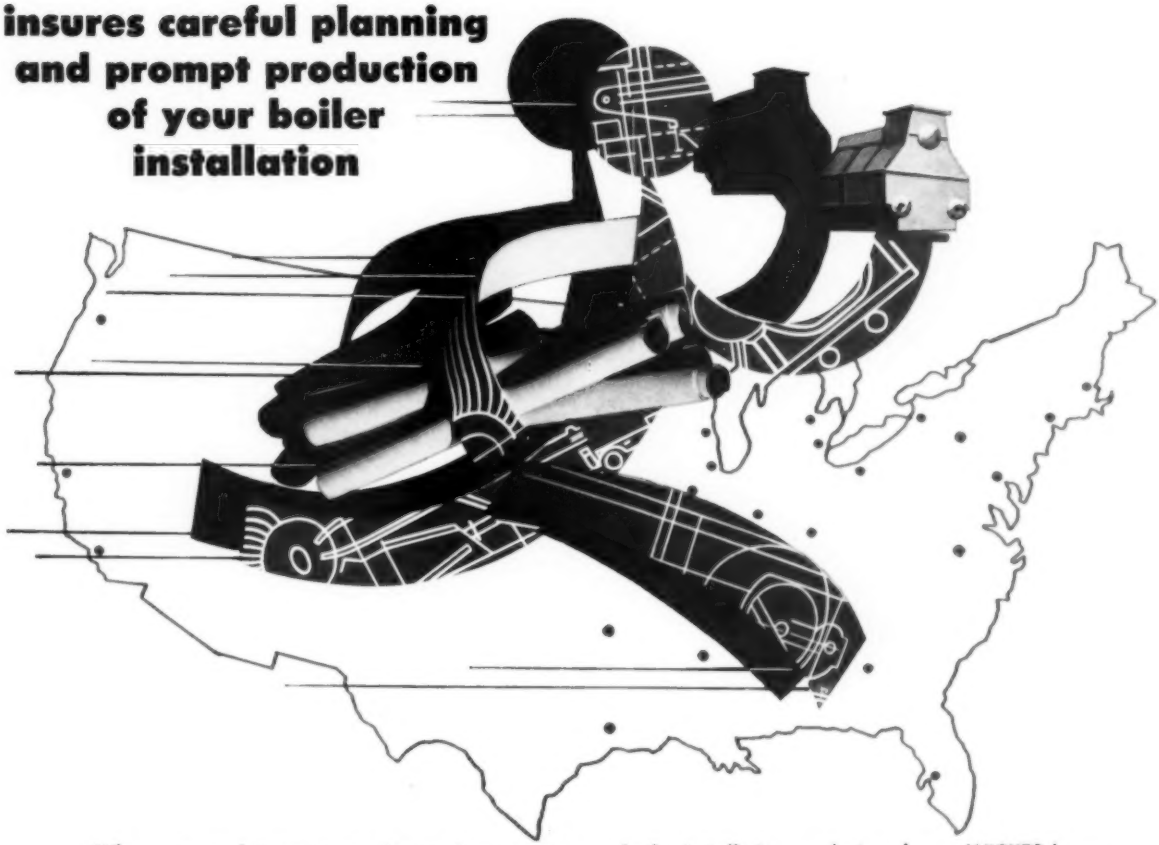
820 Maple Street • Three Rivers, Michigan

WICKES SERVICE

insures careful planning and prompt production of your boiler installation



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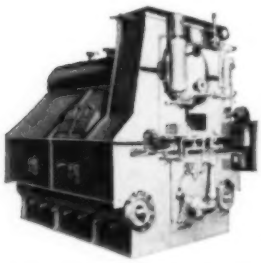
WICKES can fill your requirements for steam generators up to 250,000 lbs. per hour and 1000 psi.—all types of multiple drum boilers, adaptable to any standard method of firing. Write today for descriptive literature or consult your nearest WICKES representative.



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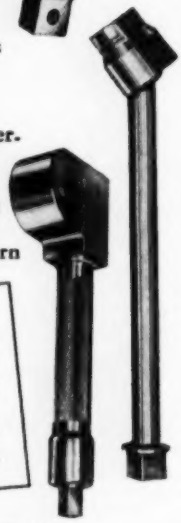

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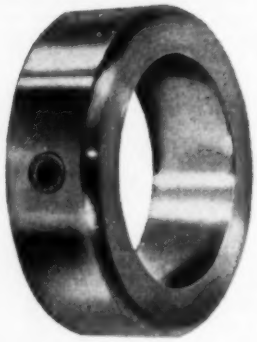

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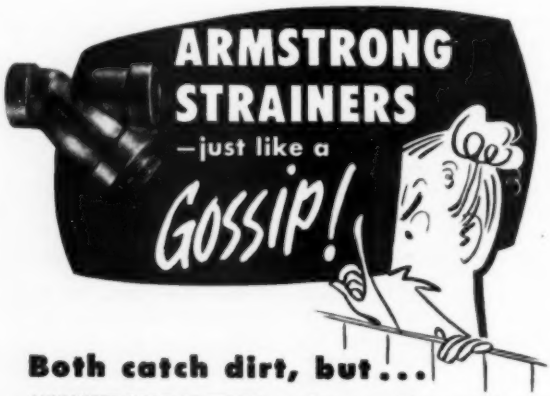

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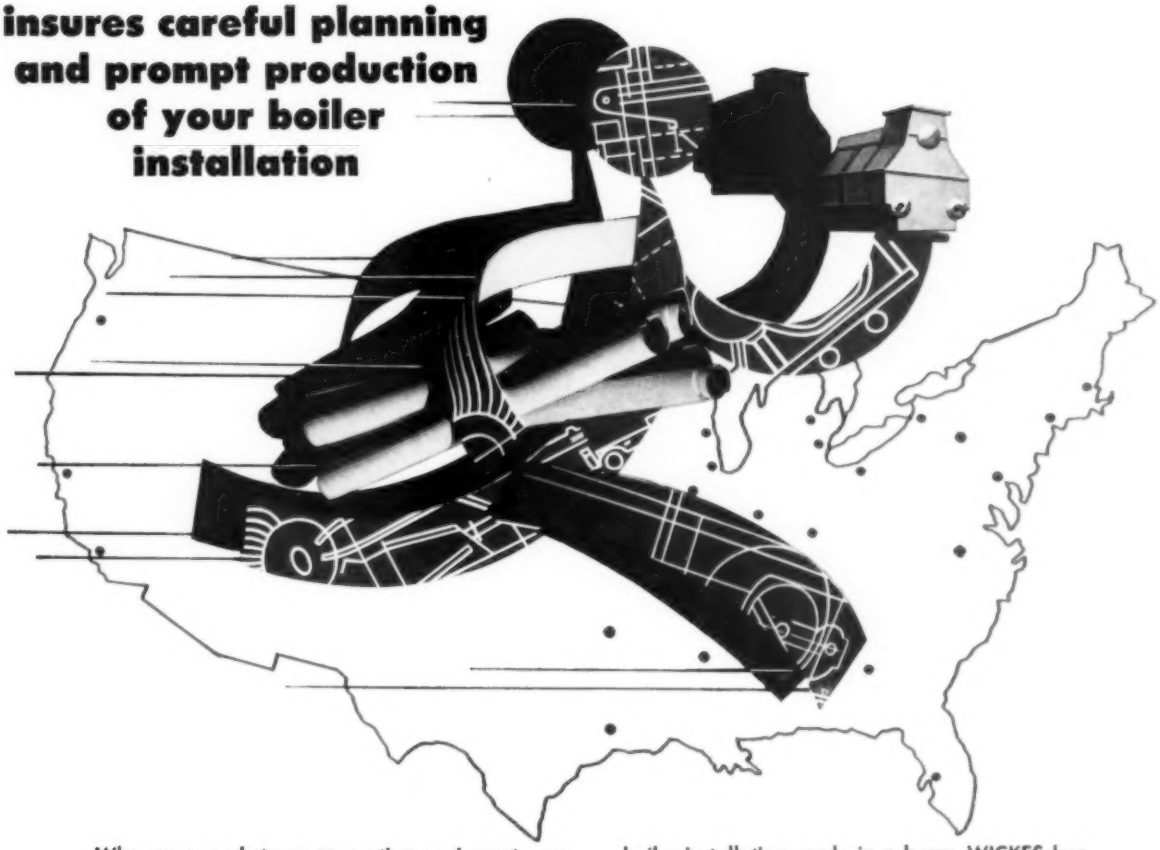

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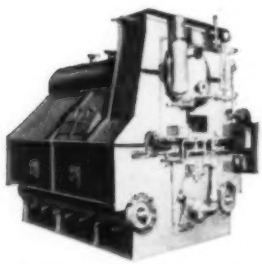

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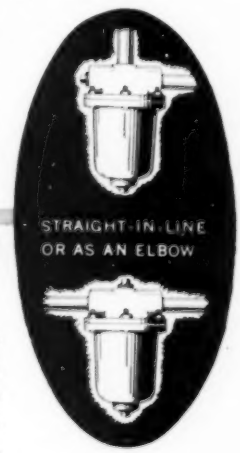

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